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Developments in Power Plants and Generating Stations

Hydroelectric and Steam-Electric Stations—Economical Considerations—Coal and Oil as Fuel—Water and Steam Turbines—Generators — Methods of Excitation — Trend of Transformer Design

By ALFRED STILL

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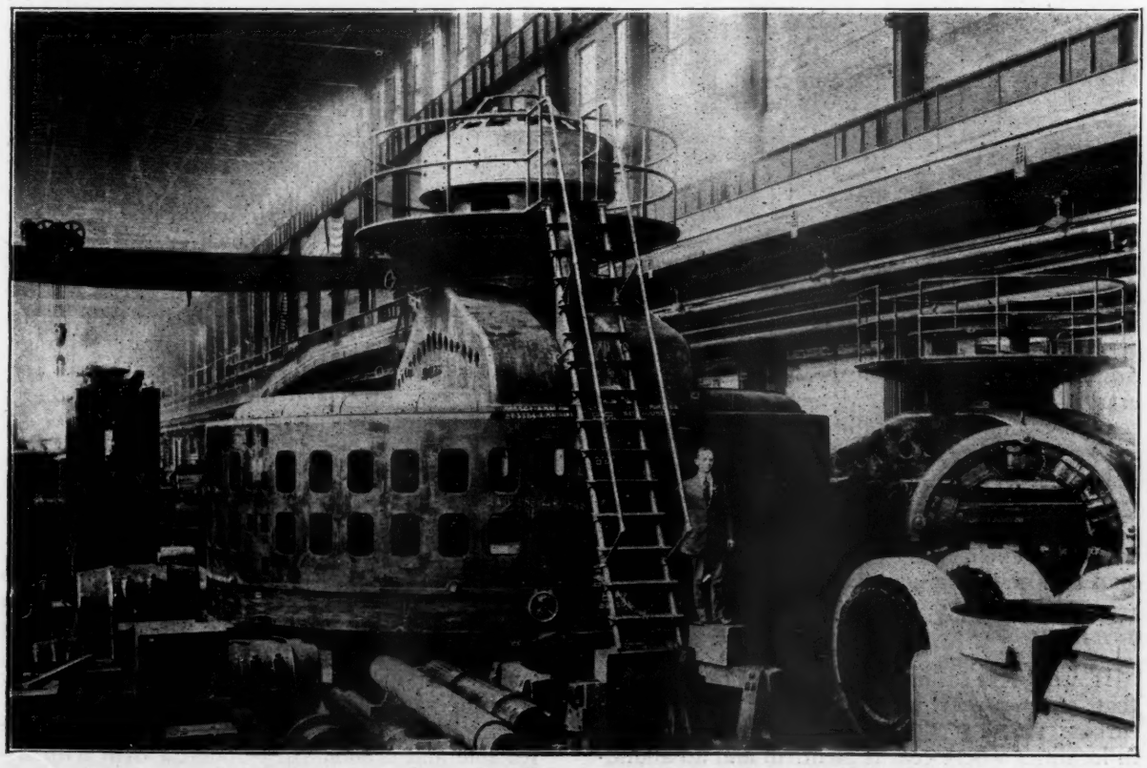
This is the third of a series of articles in which Prof. Still reviews the electric power situation. The purpose is to indicate the general nature of the problems the engineer has had to overcome and to show in what way present tendencies may influence future practice.

The first article, which appeared in the July 17 issue of ELECTRICAL REVIEW, reviewed present-day conditions and practice in the development of electric power plants and distribution systems. The second article, which appeared in the Aug. 7 issue, presented a review of various types of transmission systems. Subsequent articles will be published in the "Electrical Construction" and "Central-Station and Power-Plant" issues.—EDITOR'S NOTE.

On June 11, 1920, President Wilson signed the new water-power law, the final result of eight years of work by committees of Congress. There would seem to be no reason to doubt that the passage of this law will lead to a considerable increase in the amount of water power to be used for industrial purposes. Failure of Congress to pass satisfactory laws under which the investor could see a fair prospect of return on his capital has resulted in much of the available power on navigable streams being wasted.

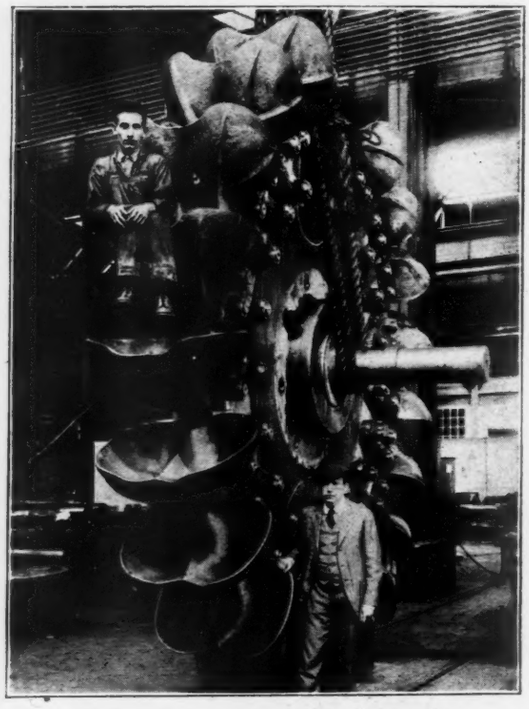
Workable schemes aggregating a total of approximately 2,000,000 hp. have been held back for lack of the necessary encouragement and se-



Shop Assembly of a 17,500-Kv-a., 6600-Volt, 100 R.P.M. Vertical Waterwheel Generator for Wateree Power Co.

curity, while the upper reaches of many streams and rivers have remained closed to navigation which hydroelectric developments in the near future will probably open up at almost no cost to the government.

Coal shortage and present-day labor problems clearly emphasize the importance of utilizing water-power sites when this can be done economically. Since the close of the war practically all countries are now seeking to develop their water-power resources to the maximum extent. In France the new Soulon and Eget plants utilize some of the high-head sites in the Pyrenees. These two stations can supply a total load of 40,000 kw., but their completion was a direct result of the coal shortage during the war. An expenditure amounting to over $200,000,000 is contemplated in the development of something like 700,000 hp. which it is estimated is now running to waste in the Rhone valley. Sweden, which is at present paying little short of $50 per ton for coal (imported from England) is about to develop a large part of the 5,000,000 hp. which has not yet been utilized by the many hy-



Large Runner for Waterwheel of Pelton Type.

droelectric schemes which were in successful operation before the war. Even Great Britain is seriously contemplating the further development of her somewhat meager water-power resources.

In this country, notwithstanding difficulties in obtaining the necessary capital, existing hydroelectric plants have been increased in capacity wherever extensions were feasible. The peak load at Keokuk is now well over 100,000 kw.

Water-Power Versus Coal-Burning Central Stations.

It would be a mistake to overlook the fact that steam-power plants equipped with steam turbine units of the larger sizes, and situated in localities where coal is plentiful and an abundance of water for condensing purposes is available, can generally compete favorably with hydroelectric stations. As a general rule, the water-power site is at a considerable distance from the center of demand, and the cost of erecting and maintaining a long high-tension transmission line offsets the advantage of not having to pay for coal. On the other hand, as steam-power stations increase in capacity, the question not only of coal supply but of the severe requirements in the matter of condensing water may lead to fairly long transmission lines being necessary in connection with the so-called super-power fuel-burning generating stations which are being seriously considered not only in this country but also abroad.

Comparisons between steam and water-power stations should be made with an open mind, without prejudice, and it will undoubtedly be found that there is room for both when an impartial investigation is made on economic grounds. At the same time, if we are to consider the ultimate trend in this respect, it is likely to be in the direction of developing all available water-power sites if only with a view to conserving our coal resources for heating rather than for power purposes.

When comparing steam-electric with hydroelectric power, it is well to bear in mind that while the larger steam turbine units operate at high efficiency, improvements have also been made in water-power machinery. Waterwheel efficiencies exceeding 90% are now common. Large units even on medium-head installations have efficiencies reaching as high as 93%. Not many years ago an efficiency in the neighborhood of 80% was considered very good.

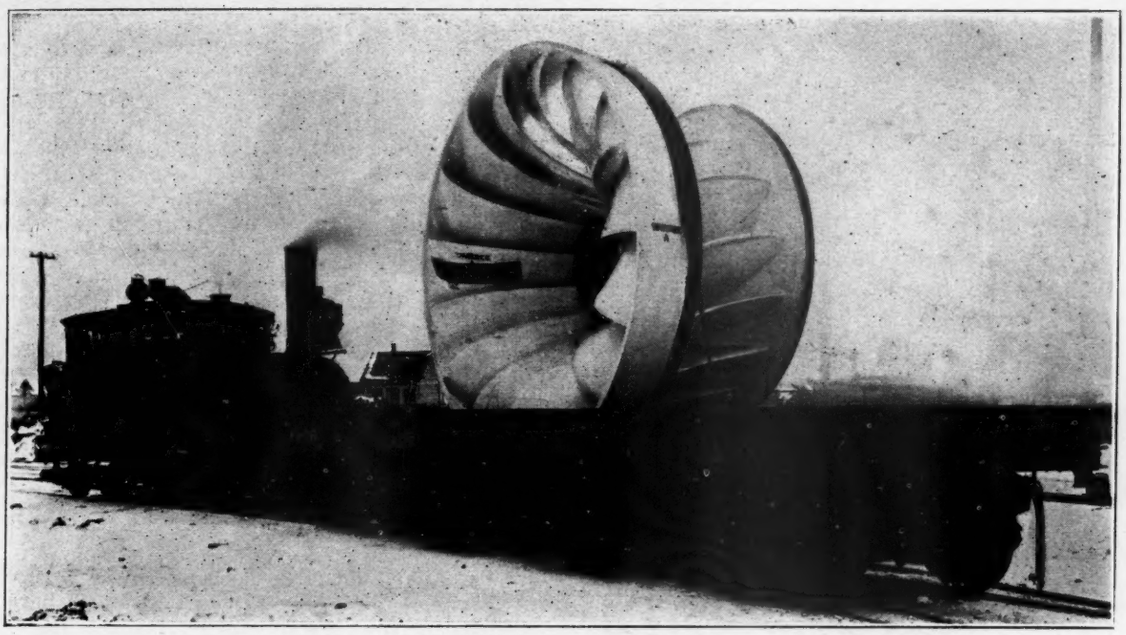
Points on the Economics of Hydroelectric Development.

Without attempting to make a detailed study of power-station economics, the mere mention of a few fairly obvious considerations may serve to explain why some hydroelectric developments have been successful while others were doomed to failure from the outset.

In the first place, long-distance transmission of electrical energy has been the cause of many water-power sites being available and financially successful which otherwise would not have been worth developing. This, however, does not justify the equipment of any hydroelectric scheme with an amount of apparatus in excess of the power available at minimum stream flow unless adequate provision is made for water storage. The cost of dams and large reservoirs is frequently very great and the engineer must therefore consider very carefully the alternative of auxiliary steam-operated plants. By constructing forebays of sufficient size to take care of daily fluctuations in the flow of water, the construction of flumes or pipe lines to carry the peak flow of water is avoided.

The steam reserve plant, besides helping to supply the load at times of low water, often serves the important purpose of preventing a shutdown when the main supply is interrupted, and it also permits of the hydroelectric plant being operated at its full output at all times.

For heads not exceeding 30 ft. it is usually feasible and economical to build a dam with the power house alongside of it, or forming part



17,500-Hp. Hydraulic Turbine Runner, 159 Ins. Outside Diameter, Made for 68-Ft. Head, to Operate at 100 R.P.M., for Wateree Power Co.

of the dam itself. When the head exceeds 30 ft. it will usually be preferable to bring the water through short penstocks to the turbines, thus utilizing a somewhat greater head than that provided by the dam itself. The possibilities of taking the water in flumes or open canals for some distance along the river to a point considerably below the dam should be carefully considerd, although very long open canals are not usually desirable.

The power canal connecting the Welland river above Niagara Falls to the power house on the Niagara river at Queenstown, will, when completed, be an example of a long power canal. This is a work of great magnitude involving the solution of many engineering problems. Fifty miles of standard gauge railroads have already been built in connection with this project, and the largest electric shovels ever constructed are used for handling the work. It is not always economical to take the canal all the way to the power house, a short distance being sometimes more economically covered by steel penstocks connecting the forebay with the individual waterwheel units in the power house.

The average cost of developing water-power sites for power purposes on a reasonably large scale is about $200 per horsepower at the present time. If the estimates indicate a cost appreciably in excess of this figure, the possible competition with fuel-burning plants should not be overlooked.

When there are no transmission line costs, the cost of power from a large steam-electric plant will be about 1.25 cents per kilowatt-hour at the switchboard, while hydroelectric power is frequently obtained at the switchboard for 0.3 or 0.4 cent per kilowatt-hour. To this must be added the transmission costs, which vary considerably, depending upon the location of the power site relatively to the industrial centers or other places where a demand for power exists.

It is a satisfaction to feel that in using water-power a very large percentage of the total energy is utilized, which is certainly not true when coal is burned for power purposes. Large waterwheels have efficiencies from 85 to 90%, and with transformers of nearly 99% efficiency result in a comparatively small waste of the natural power available.

There is a tendency nowadays to develop the low-head sites which have been neglected in the past because they are usually more costly than the high-head developments. The best results in low-head development are obtained where waterwheels for low heads are individually designed to suit the particular conditions they have to meet. In such cases efficiencies as high as 85% are probably attainable even when the hydraulic head does not exceed 20 or even 15 ft. It has been customary in this country for manufacturers to design a line of waterwheels and offer the size most nearly adapted to the requirements of the purchaser.

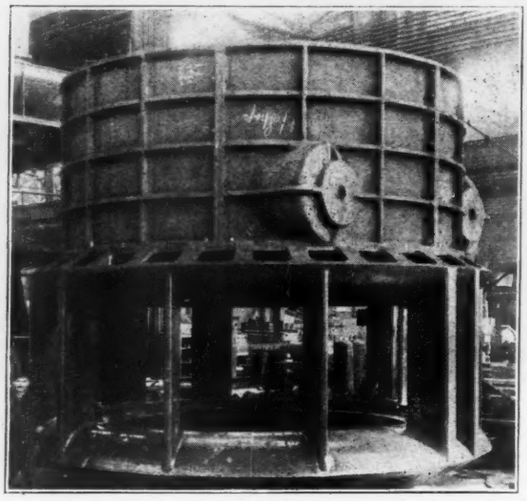
Although the prospect of further water-power developments are good, it is well to bear in mind that the investing public is easily impressed with the idea that, since water costs nothing, every projected hydroelectric development will be a source of profit. The engineer knows that this is not true, and an honest investigation will soon determine whether or not a given site may be developed successfully. It is not good policy to develop water powers which are almost certain to operate at a loss and compete unfairly with established public utility companies capable of serving the same district.

An important factor in the development of water power is the possibility of utilizing sites where great variations of flow may occur during the year, provided they could be used to serve industries capable of adjusting their demand for power to the change of the seasons. It has been suggested that the electrochemical industries might be able to operate in such a manner and so obtain large amounts of hydroelectric power

cheaply during the seasons when the water supply is plentiful.

Fuel for Boilers—Oil Engines.

In connection with steam-electric power stations, a good deal of experimental work has been done with pulverized coal. During the last



Cast-Iron Speed Ring and Pit Ring for 20,000-Hp., 100-R.P.M., 75-Ft. Head, 120-In. Runner Hydraulic Turbine.

year or two an increasing number of electric power stations have installed powdered coal burning plants. Oil as fuel is also receiving much attention. An oil-fired plant does not cost so much to build as a coal-fired plant. There are no coal-storage piles, no coal elevators and conveyors, no coal bunkers, ash-handling machinery, or stokers. The equipment for oil-firing necessitates storage tanks, oil pumps and oil burners, together with a certain amount of piping. On the Pacific Coast fuel oil is used almost exclusively, since coal is not easily obtained.

A tendency toward higher steam pressure and higher superheat has been noticeable during the last year or two. Steam at 200 lbs. pressure has been used in a few generating stations for the last 20 years, but plants have recently been built for 250 lbs. and even for 300 lbs. pressure. Higher pressures are contemplated. It is recognized that, for the same temperature of superheated steam, the highest attainable temperature is maintained through a longer part of the range with a high steam pressure and a moderate amount of superheat than with a lower steam pressure and a greater amount of superheat. In this way increased efficiency may be obtained at no very large increase of initial cost. The increased cost is, of course, due to the machinery having to be made stronger to withstand the higher pressures.

Although the Diesel engine is more frequently met with in power stations abroad than in this country, it may be well to mention that continual improvements have resulted in a very satisfactory form of oil engine. The tendency in the larger sizes is toward two-cycle units; although it does not seem possible to effect much reduction in fuel consumption, the later types of engine are capable of using the lower grades of oil fuel.

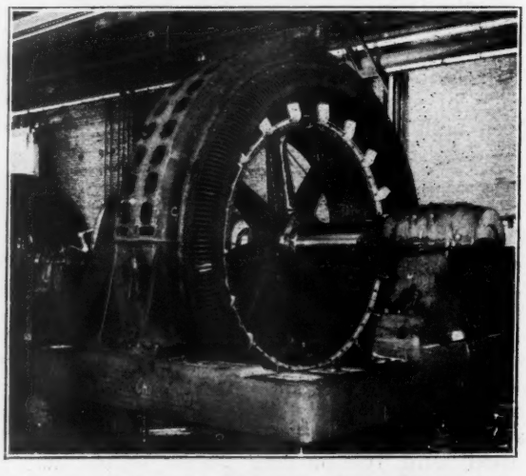
There are practically only two types of waterwheels now being installed in hydroelectric power plants. For high heads the Pelton impulse wheel is used, while the Francis reaction turbine is used for medium and low heads. This latter type of wheel is now made for heads as high as 800 ft. Pelton wheels have been constructed to operate on a 5500-ft. head. The improvement in the Francis type of turbine for the utilization of low heads has been brought about mainly by an increase in what is known as the specific speed, thus permitting an increase in the output of single vertical units as commonly used for low heads. It is now quite feasible to utilize natural heads as low as 6 ft. The reader is referred to the *Journal of the A. S. M. E.*, December, 1919, for a description of a new high-speed runner which is specially adapted for use on low-head sites.

Prime Movers in Hydroelectric Generating Stations.

The single unit of largest capacity in the world is probably the 37,000-hp. turbine made by the Allis-Chalmers Manufacturing Co. for the Niagara Falls Power Co. This wheel is designed for a head of 214 ft.; it is direct-connected to an alternator of 32,500-kv-a. capacity.

The same company has supplied the 30,000-hp. double overhung unit impulse wheel to the Great Western Power Co. for its Caribou plant. This wheel is designed for a 1003-ft. head. The largest single discharge turbine in the world is the 20,000-hp. wheel at the Wise power plant of the Pacific Gas & Electric Co.

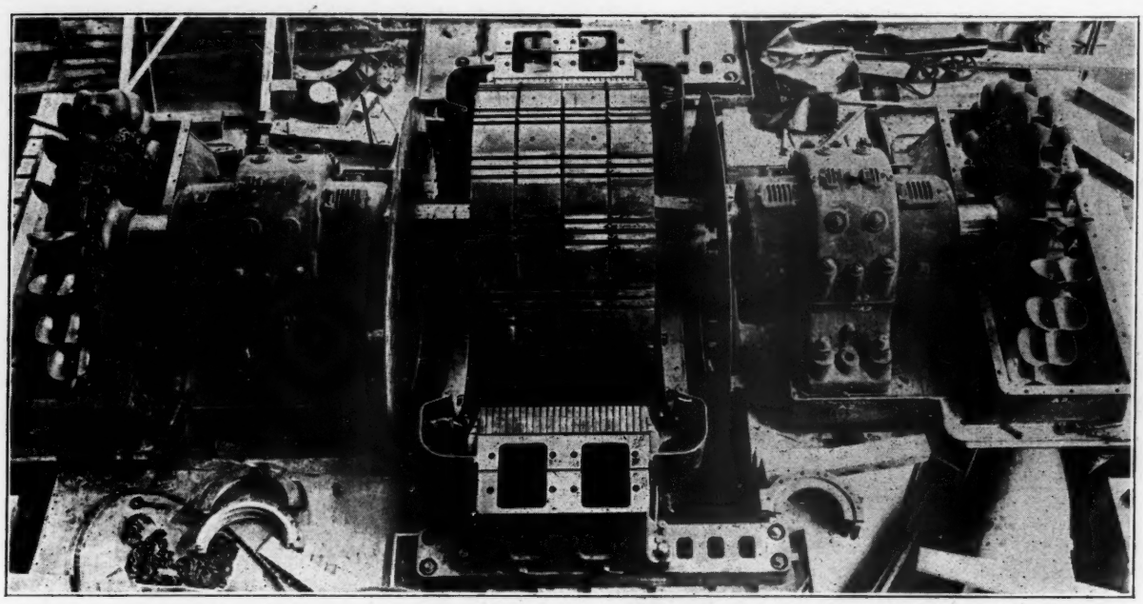
There are no very high-head turbines operating in America. In Norway, the Aura plant with a head of 2350 ft. is one of the finest examples of high-head development. Other important plans in various parts of the world op-



6250-Kv-a., 12,000-Volt, 200-R.P.M., Three-Phase Waterwheel Type Generator for Columbus (Ga.) Power Co.

erate under heads varying from 1000 ft. to 1650 ft. (the Tata plant, Bombay). A notable high-head plant which was in successful operation 16 years ago is the hydroelectric station in the canton of Valais, Switzerland, which utilized the water of Lake Tenay with an effective head of 3018 ft.

It may not be out of place to mention that automatic hydroelectric plants are rapidly com-



Shaft with Runners and Rotor Spider in Bearings for Twin Horizontal Impulse Waterwheel—Two 20,000-Hp. Units for 1900-Ft. Head to Run at 375 R.P.M.—Made by Allis-Chalmers Manufacturing Co. for Pacific Light & Power Co.

ing into favor. They work without attendants, the gate openings being regulated by the head of water in the reservoir through a system of floats. Their purpose and advantages are well described by A. B. Darling, in the *General Electric Review,* of Nov., 1919.

Prime Movers in Steam-Electric Generating Stations.

The largest single-shaft, single-barrel steam turbine units recently built in this country are for an output of 30,000 kw. at 1800 r.p.m. for 60-cycle generators, and 35,000 kw. at 1500 r.p.m. for 25-cycle generators. In Europe, the Allgemeine Elektrizitats Gezellschaft is building two single-shaft, single-barrel units to drive 50,000-kw. generators. These machines, which were described in Electrical Review of July 3, 1920, p. 15, will be the largest single unit machines in the world.

Larger units are not likely to be seen in the immediate future, although combinations of compound turbogenerators are quite practical and indeed desirable, in order to limit the number of machines in the very large power stations now operating or being planned. The very high peripheral speeds and the difficulty of attaining the necessary stiffness in the rotating parts introduce very serious mechanical problems in the design of large single units. Several wheel failures that have occurred recently in steam turbines appear to be due to vibration of the wheel structure. These troubles are being investigated. In the meanwhile the tendency has been in the direction of thicker turbine discs (to reduce vibration), the avoidance of holes for the balancing of the rotating parts, and certain improvements in the design of the buckets.

Alternators and Exciters.

In the design of large polyphase generators to be driven by steam turbines, the limit of output depends very much upon the maximum peripheral speed. Another problem is the method of cooling or the means of getting rid of the enormous amount of energy which appears in the form of heat. When the diameter is limited by peripheral speed the axial length of the machine must necessarily increase with the output, and this introduces mechanical difficulties besides leading to a design which does not always produce the most efficient machine. It is doubtful if a single-unit, 50,000-kv-a. generator can be built of as high an efficiency as the existing 35,000-kv-a. units. (There is one single-unit turbogenerator in operation in this country designed for an output of 45,000 kw. It is in the power station of the Detroit Edison Co.) On the other hand, large units in a station of great capacity may be desirable even if not quite so efficient as smaller units.

The occasional failure of insulation in large electric generators can generally be traced to high temperatures. It is difficult to determine where "hot spots" will occur, but the copper conductors at the center of the armature slots will usually attain a temperature higher than will be found in other parts of the machine. The practice of embedding small resistance coils or (preferably) thermocouples at one or more places where high temperatures are to be expected is becoming more and more common. It has much to recommend it, because surface or average temperatures are a very unsatisfactory indication of what the highest local temperature may be. Attempts are being made to increase the output of machines by providing insulations which will withstand high temperatures; but a great deal has already been accomplished by providing adequate air circulation.

The excitation of alternating-current generators in modern power stations is obtained either from direct-current busbars used for the common excitation of all generators, or by providing each generator with its own exciter, usually mounted on an extension to the shaft. The use of individual exciters forming part of the generator unit appears to be gaining favor. These exciters are sometimes compound wound and sometimes provided with automatic regulators.

2500-Kv-a., Single Phase, 25-Cycle, 33,000-Volt, Combination Self and Water-Cooled Transformer in Service on Lines of Ontario Hydro Power System, Windsor, Ont., Can.

Simple shunt-wound machines with hand regulation will, however, generally answer all requirements.

Modern Tendencies in the Design and Operation of Transfomers.

It is well known that the alternating-current transformer is an extremely efficient piece of electrical machinery. At the same time improvements in the grade of iron used will always be welcomed because they will lead to reduction in the amount of material needed and an appreciable improvement in the all-day efficiency of transformers that are only lightly loaded during a considerable period in every 24 hours. With a good quality of iron it is possible to use fairly high flux densities and so effect a reduction in weight and cost. The proper proportion between iron and copper losses should be worked out to give the best results depending upon the load conditions. That, however, is one of the difficult problems to be solved in planning new developments; it is extremely difficult to foretell the load conditions. What may be called the average peak load for individual transformers on power service should be ascertained by making frequent tests of maximum current output in order to ensure against possible overheating and breakdown.

With distributing transformers, overloading is still more likely to occur unless a careful watch is kept on the number of customers connected, and the peak loads. Some attention is being paid to these problems in order to avoid installing transformers of a larger capacity than may actually be necessary. It is possible that some simple form of load indicator may be developed and put on the market before very long. There is certainly a need for a cheap instrument of this type.

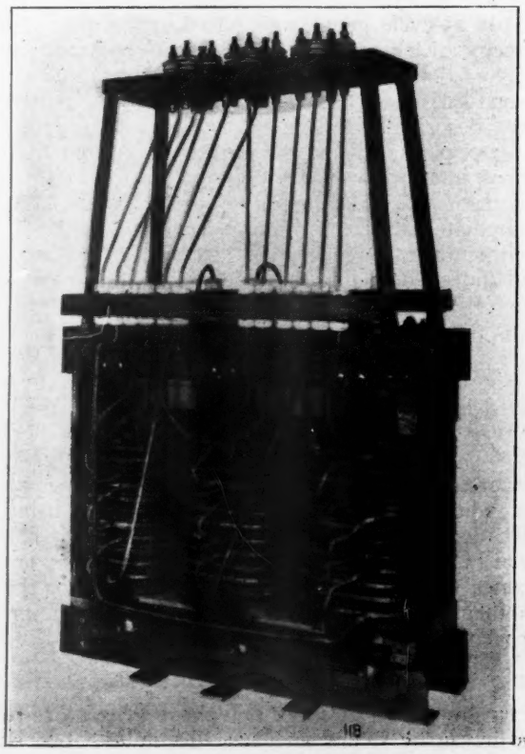
A recent development in small distributing transformers is the pressed-steel containing tank which has many advantages over cast iron. It is stronger and lighter in weight, thus permitting transformers of larger output to be mounted on poles than has been the custom with transformers in cast-iron cases.

Tanks for the larger power transformers are now frequently made of sheet steel with all joints welded. This includes the welding of a sheet-steel bottom to the vertical sides as an alternative to casting an iron base on to the corrugated sheet steel sides of large transformer tanks.

Many engineers object to the banking of transformers on the ground that considerable difficulty is likely to be experienced in restoring service after a local interruption. It is possible that such difficulties have been exaggerated and that they may be largely overcome by paying careful attention to the arrangement or layout.

One advantage to be gained from banking transformers is that few units of a large size can generally be used, thus effecting a saving in cost and a gain in efficiency. The total kv-a. capacity required is also less than if the transformers are not banked.

A bank of transformers should consist of three or more units, because when only two transformers are connected in parallel there is the possibility of the total load having to be carried by a single transformer in the event of an accident to the other, such as the blowing of its fuses. Banking transformers of different sizes



Large Three-Phase Moloney Transformer, Showing Pancake Coil Construction.

should also be avoided as each one does not always take its proper share of the total load.

Very large transformer units are now being built. Single-phase, 25-cycle, 8000-kv-a. units of the self-cooling type are in use out of doors. The large transformer without cooling coils for circulating water is the result of a demand for outdoor substations and outdoor high voltage equipment generally. Circulating water is not always obtainable or to be relied upon, and the necessary cooling surface is therefore obtained by providing a number of radiators external to the containing tank proper, but connected thereto at the bottom and near the top just below the oil level. Three-phase, self-cooling transformer units have been built up to 12,000-kv-a. capacity. Single-phase units with water circulation have been built for an output of 23,600 kv-a. These are 132,000-volt transformers with an efficiency of 99%. They measure 22 ft. from the floor to top of terminals and occupy a floor space 10 ft. 3 ins. in diameter.

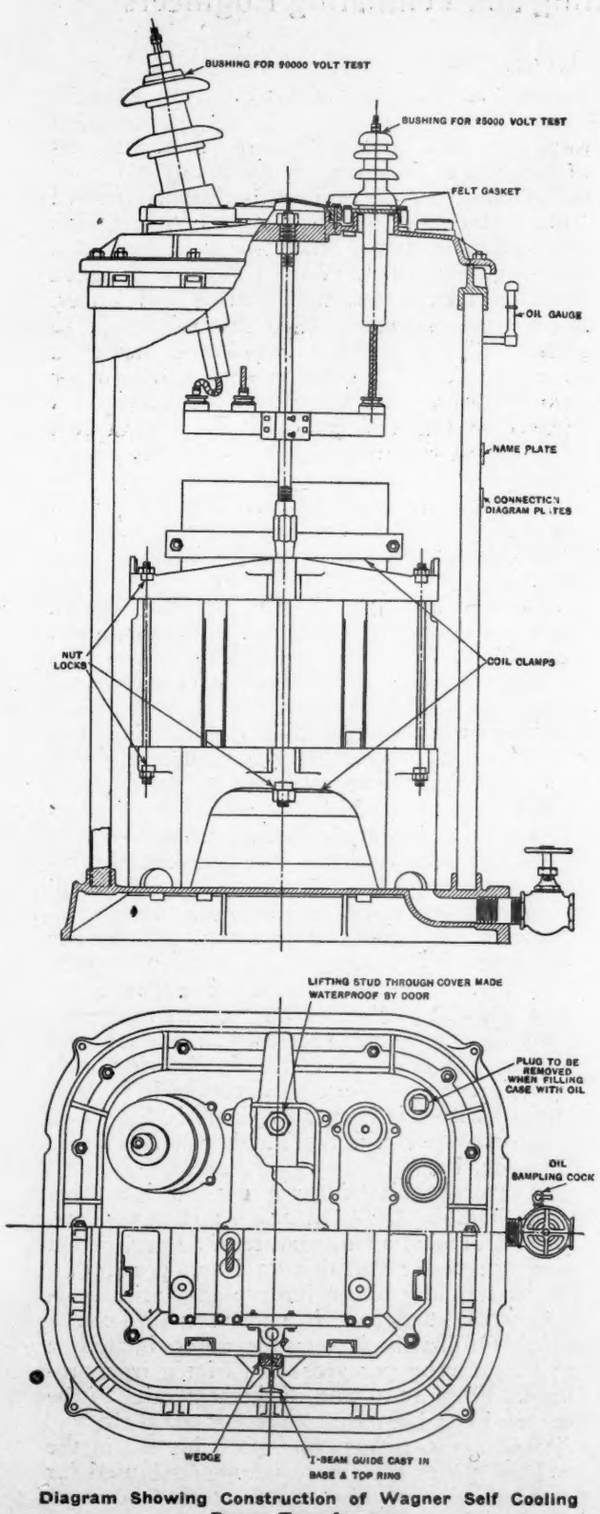

BUSHING FOR 90000 VOLT TEST
BUSHING FOR 25000 VOLT TEST
FELT GASKET
OIL GAUGE
NAME PLATE
CONNECTION DIAGRAM PLATES
NUT LOCKS
COIL CLAMPS
LIFTING STUD THROUGH COVER MADE WATERPROOF BY DOOR
PLUG TO BE REMOVED WHEN FILLING CASE WITH OIL
OIL SAMPLING COCK
WEDGE
I-BEAM GUIDE CAST IN BASE & TOP RING

Diagram Showing Construction of Wagner Self Cooling Power Transformers.

Much attention has lately been given to the question of adequate circulation and cooling of the oil in transformer tanks. The provision, near the top of the tank, of cooling coils through which cold water is circulated by pumps is well known, but the method of circulating the oil by means of pumps, and cooling it by passing it through pipes in a large cold water reservoir is not so common. It appears to be gaining favor, one advantage being that water cannot leak into the transformer tank because it is always at a lower pressure than the oil.

What is known as a transformer oil conservator has lately been introduced in connection with large power transformers. It consists of a tank mounted above the lid of the transformer case, but connected thereto by means of a pipe. The auxiliary tank is not entirely filled with oil, but an oil gauge is provided, and the space above the oil level communicates with the outside air only through a calcium chloride "breather." In this manner the transformer case is kept entirely filled with oil and the introduction of moisture is avoided. A complete description of this improvement will be found in the *General Electric Review* of October, 1919.

PRIORITY ORDER ON COAL CARS EXTENDED UNTIL SEPT. 18.

Telegraphic advices received from Washington last week by the National Electric Light Association indicate that the Interstate Commerce Commission has extended the effectiveness of Service Orders Nos. 7 and 9 for 30 additional days to and including Sept. 18, the order reading as follows:

"It is ordered that Service Order No. 7 entered June 19, 1920, as amended by Service Order No. 9 entered July 13, 1920, and that Service Order No. 9 as amended by order entered July 29, 1920, be, and they are hereby, continued in force and effect for a period of 90 consecutive days beginning with June 21, 1920."

The above service orders have reference to priority in the use of open-top cars in favor of coal loading.

NATIONAL COMMISSION REPORTS ON PUBLIC UTILITIES.

The commission to study the economic condition of street railways and public utilities throughout the United States, appointed by President Wilson more than a year ago, has filed its report. The report is expected to be made public in a few days, and is understood to contain suggestions for remedying financial and labor troubles in which many utilities find themselves.

Factors in the Design of Large Boiler Plants—Part I.

Discussion of Principal Points Affecting Equipment of Boiler Plants of Large Capacity — Paper Before Eastern Pennsylvania Chapter, American Society of Heating and Ventilating Engineers

By J. GRADY ROLLOW

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The boiler plant, being susceptible to infinitely more influences than any other institution connected with the generation of power, the designing engineer must thoroughly acquaint himself with every condition which may affect the operation of the plant before he can undertake the design. The principal influences are enumerated below under 13 different headings. The first eight of these may be likened to the tools of a stone mason, by means of which the designer builds the structure. The remaining five may be likened to the plumb of the mason, by means of which the designer tries his work. If the work does not fit the gauge the structure must be rebuilt.

Following are points of information the engineer must know before he can successfully design a boiler plant:

(1) Character of the fuel to be used.
(2) Location of the plant with respect to fuel supply.
(3) Character of the water to be used as boiler feed.
(4) Size and character of the load to be carried.
(5) Distribution and use of steam.
(6) Cost and class of available labor, and location of plant with respect to labor markets.
(7) Cost of fuel.
(8) Climatic conditions and altitude.
(9) Importance of the time element in getting plant either partially or wholly in operation.
(10) Local laws governing design and manufacture of pressure vessels, issuance of smoke, workmen's compensation acts, etc.
(11) The return expected on the capital invested.
(12) Permanence of plant.
(13) Value of real estate.

Consideration of Various Fuels Used for Raising Steam.

Gas.—The first item for consideration is the fuel supply. Fuels occur in all the three states of matter, viz., solid, liquid and gaseous. At the present time nearly all the large plants burning gas are those in connection with blast furnaces, although there are still a few in West Virginia, Ohio and California burning natural gas.

Ambrose N. Diehl is the author of an instructive paper on "Burning Blast Furnace Gas," published in the 1915 Year Book of the American Iron and Steel Institute. This paper covers experiments with four distinct types of burners applied to boilers with several modifications of each. Included in the paper are the experiments of C. J. Bacon conducted at the South Works of the Illinois Steel Co. The conclusions reached from a study of Mr. Diehl's work is that high boiler efficiency is not absolutely dependent upon the design of burner. With a properly designed furnace, clean boiler, tight setting and baffles, and careful regulation, high efficiencies can be gotten with the common type burner having a narrow orifice at the exit and no provision for mixing the gas and air within the burner. A furnace of ample length with an incandescent roof is most essential. The experiments clearly showed that a scientificaly designed burner was a great aid in obtaining good regulation, and with the class of help ordinarily found in boiler plants would give better results than common burners.

Some modification of the Birkholz-Terbeck burner is considered by a number of eminent engineers to best meet the requirements. This burner gives equal satisfaction on producer gas. Its success is no doubt due as much to the flexibility of the air control as to the fact that it is fitted with an observation glass concentric with its axis, so that the operator can see the flame.

Another burner which has attracted considerable attention is the Bradshaw burner which is of the aspirating type based on the venturi principle. As gas pressures are constantly changing in blast-furnace work, requiring constant air adjustments for proper combustion, this burner was designed to automatically draw in its own air supply. The draft in the furnace is automatically held at a predetermined pressure near zero. When the gas supply increases in pressure the velocity at the throat increases, drawing in a large air supply. Very good results have been obtained with this burner by Cambria Steel Co., Johnstown, Pa., and the Pittsburgh Steel Co., Monessen, Pa.

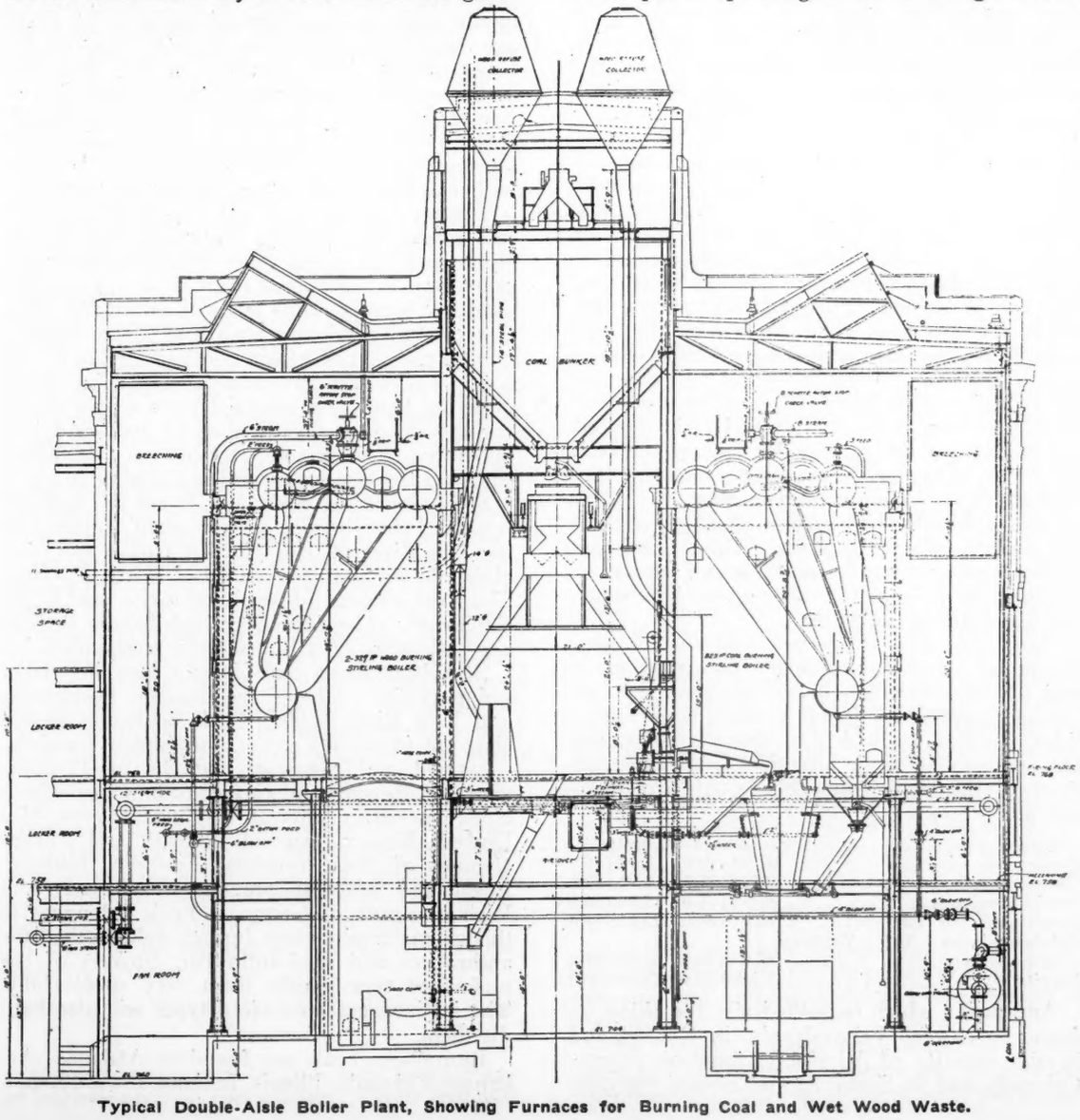
An average blast-furnace gas on lake ores runs: CO_2, 12.5%; CO_1, 25.4%; H, 3.5%, and N, 58.6%, and at a temperature of 62 deg. F. and 30-in. barometer contains 92 B.t.u. per cu. ft. The heat value of blast-furnace gas varies from 85 to 100 B.t.u. per cu. ft. under standard conditions. Ordinarily it requires approximately a net ton of coke per gross ton of pig iron produced. From 45 to 50% of the heat value of the fuel used in a blast furnace passes off at the top. Of this, about 10% is lost, 30% burned in the hot blast stones and the remaining 60% used for producing power either under steam boilers or in gas engines.

The Babcock & Wilcox Co. states that 0.8 sq. in. of gas opening per rated horsepower will enable a boiler to develop rating with 2 ins. gas pressure. As gas pressures run from 6 in. to 8 ins., the above proportion will be good for ordinary overloads. The air opening should also be about 0.8 sq. in. per rated horsepower. Boilers burning blast-furnace gas should be provided with approximately 0.75 in. of draft at damper. It is safe to figure 150% of rating on boilers properly set and cared for when using blast-furnace gas.

Wood Waste.—There are a number of plants in the United States using waste wood either as part or all of their fuel supply. Wood burning requires large furnace volumes. Just how far can be successfully gone in the matter of large furnaces for dry waste wood is not known, but the accompanying illustration showing a typical double-aisle boiler plant with furnaces for burning coal or dry wood waste indicates that some long steps have been taken. This plant has been in successful operation for six months and ratings of 200% have been devedoped for 24 hours. The fuel is dry sawdust and shavings.

The Georgetown plant of the E. I. du Pont de Nemours & Co., which manufactures grain or ethyl alcohol from wood waste from the Atlantic Coast Lumber Co., burns about the lowest grade wood waste on record. The material is 50 to 80% sawdust and the rest hogged chips. After going through a digesting and liquor-extracting process, it is run through an Edgerton garbage press, which is essentially an apron feeder moving between the rolls of a glorified clothes wringer. After going through this dehydrating process the spent wood containing 60% moisture is delivered to the boiler furnaces by conveyors. The heat value of this material is 9100 B.t.u. per lb. dry, and this plant burns sufficient of this material to develop rating on the boilers. Continuous ratings of as high as 130% may be obtained with wood waste running 50% or less in moisture. Essential features of a well-designed furnace for wet wood waste include: (1) Restriction at the furnace outlet, and (2) combustion chamber between furnace outlet and the innermost pile.

Bagasse.—There are some comparatively large boiler plants operating in the cane-sugar indus-



Typical Double-Aisle Boiler Plant, Showing Furnaces for Burning Coal and Wet Wood Waste.

try which burn green bagasse. This fuel has a net heat value of from 2200 to 3350 B.t.u. per pound. In the early days of the industry in this country, when labor was cheap and European competition played no part, the very crudest methods were used in the extraction of the juice. Oftentimes the extraction was sacrified so that there would be enough bagasse for fuel and the bagasse was sun-dried before burning. Today, with modern methods of manufacture, the extraction has reached 80% and above, and the bagasse can be burned without drying. Naturally the higher the extraction, the better grade of fuel is produced, but at the same time the more juice there is to be evaporated, and consequently the more power required per ton of cane, so that today the problem of the engineer in the cane-sugar industry is to design a plant sufficiently economical to generate the power with the bagasse. Prof. Kerr has found that the bagasse from one ton of cane will produce from 1.16 to 1.44 boiler hp. for 24 hours.

At present it is necessary to use auxiliary fuel in the United States and the West Indies, although it is the belief of some engineers that the time will come when bagasse will supply the entire fuel for the industry.

The Babcock & Wilcox Co. has developed a furnace for burning green bagasse which nearly meets this requirement. It has been found that bagasse burns better on a hearth than on grates, the air being supplied through a series of tuyeres by natural draft. Large combustion space is necessary and it is more economical to burn it in large quantities. Thus a furnace has been developed which will serve two boilers. With 0.5-in. draft in this furnace, 450 lbs. of 50% moisture bagasse per square foot of hearth per hour can be burned. Three hundred pounds per square foot per hour gives the best results. An essential feature of a well-designed bagasse furnace is provision for catching and removing the dust which will fuse into a glass-like clinker if allowed to accumulate. The fuel is introduced into the top of the furnace by conveyors which should be so designed as to give a constant fuel feed with a minimum admission of air.

Bagasse-burning boiler plants usually give from 90 to 100% of rated capacity. There is no particular reason why greater capacities cannot be obtained, as it is just a question of how much fuel the furnace can burn.

Coal.—The most important fuel for the generation of steam in stationary power plants is coal. It is more widely distributed than any fuel (wood excepted), is found in much larger quantities, varies more widely in characteristics, and has commanded more attention from engineers than all other fuels combined. Coals are classified as:

Kind.	Fixed Content.	Volatile.
Anthracite	97.0 to 92.0	3.0 to 8.0
Semi-anthracite	92.5 to 87.5	7.5 to 12.5
Semi-bituminous	87.5 to 75.0	12.5 to 25.0
Bituminous (or Eastern)	75.0 to 60.0	25.0 to 40.0
Sub-bituminous (or Western bituminous)	65.0 to 50.0	35.0 to 50.0
Lignite	Under 50.0	Over 50.0

Anthracite, which is geologically the oldest, is found in eastern Pennsylvania, in Pulaski and Wythe counties of Virginia; Gunnison county, Colorado, and in Santa Fe and Socora counties, New Mexico. The only anthracite fields of importance, however, are the five of eastern Pennsylvania, which are enumerated as follows: (1) The southern or Pottsville field; (2) the western or Mahoney and Shamokin field; (3) the eastern middle or upper Lehigh field; (4) the northern or Wyoming and Lackawanna; (5) the Loyalsock and Mehoopany fields.

Today the demand for anthracite coal for domestic purposes is so keen that engineers of steam plants need to concern themselves with the buckwheat sizes and smaller only. Sizes smaller than No. 3 buckwheat cannot be burned successfully in hand-fired furnaces unless mixed with some bituminous coal. The Arlington plant of the du Pont company successfully burns a mixture of one part bituminous to two parts of small barley, obtaining efficiencies of 68% and ratings of 140%. During the recent soft-coal strike a mixture of one part of bituminous to four of anthracite was used, but with a decrease in capacity to 110% of rating and a corresponding decrease in efficiency. The steam sizes of anthracite require forced draft. Fans should be provided which will give 3 ins. of static pressure at the fan where hand firing is used. The common practice in the anthracite region a few years ago was to use stacks from 25 to 50 ft. above the boiler setting. This is entirely wrong, as it limits the capacity very materially. There is less reason why anthracite with forced draft should require short stacks than underfeed stoker plants burning bituminous because anthracite requires higher drafts for the same combustion rates.

The best known of the early types of mechanical stokers for burning anthracite coal is the Wilkenson. In recent years stokers of the chain-grate type, using forced draft, have been developed for burning small sizes of anthracite. This type of stoker will also burn coke breeze or bituminous coal. It will burn continuously 25 lbs. of No. 3 buckwheat anthracite coal per sq. ft. of grate per hour. An essential feature of a stoker for this work is the dividing of the wind box into three or more compartments so that different pressures may be carried in different zones.

Semi-anthracite coals are found in Sullivan county, Pennsylvania, and in small amounts in the Dan River field of North Carolina and Virginia and the Deep River field of North Carolina. The total amount of semi-anthracite coal is insignificant. The furnaces which handle anthracite satisfactorily will also burn semi-anthracite.

Semi-bituminous coals form a very important group, which includes the famous Pocahontas and New River fields. Coals belonging to this class are found in Center, Huntingdon, Cambria, Clearfield and Somerset counties of Pennsylvania; Allegheny and Garret counties of Maryland; Tazewell county of Virginia; Fayette, McDowell, Mercer, Mineral, Raleigh and Tucker counties of West Virginia; Franklin, Johnson, Logan and Sebastian counties of Arkansas, and Walker county of Georgia. Fuels belonging to this group require more furnace volume than the anthracites and semi-anthracite. Stokers of the underfeed type handle them very successfully. The inclined grate overfeed types will also handle them.

Bituminous coals are found in Alabama, Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas.

Kentucky, Michigan, Missouri, Montana, New Mexico, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Virginia, Washington, West Virginia and Wyoming. The bituminous coals offer more opportunities for the various types of stokers. The better grades of bituminous can be successfully burned in the underfeed and the inclined-grate overfeeds. The chain-grate stoker handles the low-grade bituminous coals very successfully, although the underfeeds have been invading the lowgrade bituminous territory during recent years. Each type has its peculiar advantages which make it acceptable under certain conditions. Generally speaking, high-ash bituminous coals handle better on chain grates. This gives them the advantage of a large territory in the Middle West and West. Indiana coals, however, have a certain characteristic which makes them difficult to handle on chain-grate as well as underfeed stokers. Here the Roney stoker, which has been distanced in other fields by the underfeed type, still has a deservedly loyal following. The forced draft chain grate similar to the type used for burning anthracite is also breaking into the low-grade bituminous field. The Commonwealth Edison Co., Chicago, is now experimenting with a stoker of this type, burning Illinois coals. This concern has retained the chain-grate in the face of the advances of underfeed stokers.

The sub-bituminous coals are found in California, Colorado, Montana, New Mexico, Oregon, Utah, Washington and Wyoming. Lignites are also found in these states as well as in the Dakotas and Arkansas.

Up until 1911 there were comparatively few stokers in the sub-bituminous and lignite territory. The Denver Tramways, however, have been using chain grates for over 20 years and there were at that time a few installations of the standard Jones. In 1912 the Great Western Sugar Co. installed two chain-grate stokers in its Billings, Mont., plant. It had been the general opinion up to that time that beet-sugar plants could not afford stokers because they operated only 100 days out of the year. About 40 tests were conducted on these stokers and similar boilers hand fired burning different grades of Wyoming lignites and Montana coals. These tests upset the old theory and several large sugar mills installed chain grates. It was found that with a 200-ft. stack giving a draft of about 0.50 in. in the furnace, the chain grates would burn 25 lbs. of dry lignite (average moisture content 23%) per sq. ft. of grate per hour, giving 25% more capacity and 8% greater economy than the hand fires. A few years later the multiple retort underfeed made its entrance into these fields and has made a good showing. It is the writer's opinion that where the load is a fairly constant one for 24 hours per day, as in a beet-sugar mill, the chain grate has the advantage. Where the load varies greatly with high peaks, as in a central station, the underfeed stoker will make a better showing This will be especially true where high-ash fuels are used on the chain-grate and low ash on the underfeed stoker.

Location of Plant With Respect to Fuel Supply.

Plants burning such fuels as blast-furnace gas or bagasse need no fuel storage. Plants removed from the source of supply should provide fuel storage of sufficient size to insure against shutdown. In the oil-burning plants of the du Pont company, 40 days' storage is considered safe. This fuel comes from Mexico.

A point which belongs under the discussion of "character of the fuels used" no doubt is the question of spontaneous combustion of coals. The causes of spontaneous combustion have been discussed at length and there is still room for discussion. Generally speaking, the lower the volatile content of the coal the less is the liability of spontaneous combustion. It is fortunate that some very eminent authority has said that the exceptions prove the rule. There are enough exceptions to the above general statement to prove it beyond any peradventure. H. H. Stoek and W. D. Langtry prepared a short paper on "Spontaneous Combustion of Coals," which was distributed during the war by a department of the National Board of Fire Underwriters. An engineer designing a boiler plant to burn a coal susceptible to firing would do well to follow as nearly as he can the nine conclusions of that paper.

(1) Pile the coal to be placed in storage as shallow as possible in the available space.
(2) When the coal is unloaded, if it should be lump, egg or nut, see that it is not broken by allowing it to drop a great distance and thus form smaller particles, which may be the source of trouble later on.
(3) See that the coal, when it is unloaded, is piled flat—in other words, do not allow it to pyramid so that the lumps will segregate from the fine coal and thus form a chimney for the admission of air to the fine coal.
(4) Pack the coal tight rather than try to ventilate it. This will prevent the easy admission of air to the inside of the pile.
(5) See positively that there does not get into the pile any material such as oily waste, pieces of paper, straw, wood or anything that is of an easily combustible nature.
(6) See that the coal is not wet before being placed in storage.
(7) See that the coal is not piled over the top of hot pipes, manholes or against the outside walls of furnaces.
(8) Remember that if a fire has started in a coal pile it is bad policy to wet the pile with water unless the fire has gone so far that it is impossible to work, due to the heat and gases being driven off.
(9) If a fire has started in a pile, try to get at the source of trouble by taking the coal out and spreading it over the ground, piling it not more than 2 ft. deep, if possible. It will naturally cool down providing, of course, it is not blazing, and the coal coked until it is glowing red. If very hot it should be cooled with water.

To these suggestions may be added: Where the coal is susceptible to firing, pile it first in shallow piles, say 6 ft. deep. Allow it to weather as long a time as is possible, not less than 60 days, then pile this weather coal deeper, say 20 to 30 ft. The only way to store coal so that firing is absolutely precluded is under water. This is the only way that lignites and some sub-bituminous coals can be stored at all.

Character of Feed Water.

The four principal considerations are: (1) Incrustation or scale; (2) corrosion or pitting; (3) foaming and priming, and (4) embrittlement of the steel.

The common scale-forming materials are calcium and magnesium carbonate and calcium and magnesium sulphate in solution, and mud in sus-

pension. Calcium sulphate is the most offensive scale-forming ingredient. This is especially true when it is found alone or nearly so. Ohio river water is remarkably free from dissolved solids, although at certain times of the year it carries a large amount of mud in suspension. It carries about one grain per gallon of calcium sulphate. Previous to 1908 the city of Cincinnati had no filtration plant. Some boilers in the city had scale 0.75 in. thick and had never lost a tube. After the filtration plant went into opertaion, tube failures became prevalent. One-eighth of an inch of scale was sufficient to cause blistering and ruptures. Magnesium sulphate is not an extremely objectionable scale-forming ingredient, but in the presence of calcium carbonate will exchange with the latter, forming calcium sulphate and magnesium carbonate.

In general the problem of treating water is to remove the four compounds named above. Any water containing above 20 grains of incrusting solids per gallon should be treated. There are two methods: (1) The chemical softener, where the chemicals are lime and soda ash, and (2) the Zeolite method.

The following table from L. M. Booth Co. gives the quantities required per grain per gallon for various impurities per 1000 gals. of water treated:

	Lime, lbs.	Soda, lbs.
Calcium carbonate	0.098	.....
Calcium sulphate	.....	0.124
Calcium chloride	.....	0.151
Calcium nitrate	.....	0.104
Magnesium carbonate	0.234	.....
Magnesium sulphate	0.079	0.141
Magnesium chloride	0.103	0.177
Magnesium nitrate	0.067	0.115
Ferrous carbonate	0.169	.....
Ferrous sulphate	0.070	0.110
Ferric sulphate	0.074	0.126
Free sulphuric acid	0.100	0.171
Sodium carbonate	0.073	.....
Free carbon dioxide	0.223	.....
Hydrogen sulphite	0.288	.....
Aluminum sulphate	0.078	0.147

Based on lime containing 90% calcium oxide and soda, 58% sodium oxide.

Where waters carry mud a coagulant should be used and the water filtered or allowed to stand in a sedimentation basin until clear. Where heat is used in connection with the lime and soda treatment, the heat precipitates the carbonates, leaving the sulphates for the chemicals. The softening of water by zeolites was first introduced commercially by Dr. L. Gans of Berlin, Germany. The material marketed by him is known as "Permutit." As far as can be ascertained, it is made commercially by fusing quartz or feldspar, kaolin and sodium carbonate in an electrical furnace and then treating the mass with water. The substance resembles crushed oyster shells. Other zeolites are "Decalso," offered by the American Water Softener Co.: "Refinite," a natural product mined in Nebraska and the Dakotas, and "Barromite," another natural product which is now being offered for sale.

Zeolite is a hydrated aluminum silicate having a formula similar to $NaAl(SiO_2)_2$. The property of softening or removing the calcium and magnesium salts from the water depends upon the replacing of the sodium atom in the zeolite by calcium or magnesium in the water. When the mineral has given up all its sodium content and becomes saturated with calcium and magnesium, it can be regenerated by placing the mineral in contact with a 10% solution of sodium chloride, whereby calcium and magnesium chlorides are formed in solution and sodium is retained by the zeolite.

The cost of softening 1000 gals. of one grain water with zeolite varies from 3 to 6 cents.

Corrosion or pitting is usually caused by the presence of free oxygen, acid or sea-water. It has been found by experience that a great many waters in Colorado, New Mexico and California will cause excessive corrosion when the water is mildly alkaline with soda ash and will stop when the concentration of soda is raised above a certain point. Commander Frank Lyon of the U. S. Navy finds this to be true also in marine boilers where sea-water gets in through leaky condensers. A great deal of pitting in Colorado and New Mexico has been cured by heating the water to 212 deg. in properly vented heaters of the open type.

Priming and foaming are generally caused by sodium salts, finely divided matter in suspension or a combination of both. The matter in suspension should be removed by filtration. The remedy for sodium salts is blowing down, and should not concern the designing engineer except where it is necessary to carry high concentrations of sodium salts a type of boiler may be chosen which will carry the highest concentration. The Babcock & Wilcox Co. has successfully carried concentrations of 1500 to 1800 grains of sodium salts per gallon in the Stirling boiler by driving the steam from the middle to the rear drum and returning it through a set of auxiliary circulators to the middle drum.

The embrittlement of boiler steel due to the action of natural waters was first observed in a certain section of Illinois. The boilers of the state university at Urbana became affected and an investigation was made by the engineers and chemists of the faculty. The results of this investigation are set forth in Bulletin No. 94 of the University of Illinois, prepared by Prof. S. W. Parr. His conclusions were that the embrittlement was caused by nascent hydrogen which is liberated by the breaking down of the sodium carbonate into sodium hydroxide and acid sodium carbonate which gives up its hydrogen atom. He recommends as a remedy the introduction of an oxidizing agent. If this theory be correct, it also explains why the raising of the soda concentration in certain waters that cause pitting in weak soda solutions will stop the pitting without causing embrittlement, the pitting being caused by the presence of free oxygen which takes care of the nascent hydrogen.

There has been at least one serious explosion in the U. S. Navy due to embrittlement of plates by the use of high soda concentration from compound. In treating water, therefore, it is important to remove as far as possible sodium carbonate. It is admitted that of all the boilers carrying sodium carbonate a small percentage have suffered from the embrittling action, but the effect on these has been serious enough to warrant much thought on the subject of treating boiler water.

(To Be Continued.)

Field Leakage in Synchronous Machines

Method of Analyzing and Determining Field Leakage Between Poles of Low and High-Speed Synchronous Machines

By THEO. SCHOU

Chief Engineer, The Ideal Electric & Manufacturing Co., Mansfield, O.

In any dynamo we have to distinguish between four different fields. Of these fields two are set up or established by the direct-current excitation, and the other two are set up by the generated or induced current itself.

FIELDS DUE TO DIRECT-CURRENT EXCITATION.

Referring to Fig. 1, which diagrammatically gives the flux distribution in the magnetic circuit due to the excitation, ϕ_1 is the effective flux per pole which penetrates the armature or stator core as well as the field poles; ϕ_2 is the leakage flux per pole, which is a "dead flux" lost by leakage between the poles; ϕ_t is the total flux per pole, equal to $\phi_1 + \phi_2$, which has to be established to give the desired effective field flux ϕ_1.

FIELDS DUE TO GENERATED (OR IMPRESSED) CURRENT IN THE ARMATURE OR STATOR COILS.

Referring to Fig. 2, every armature coil, when carrying current, sets up one field, ϕ_3, which only interlinks with the coil itself (we may call this the a-c. leakage flux), and another field, ϕ_4, which also interlinks with the field coils (we may call this the a-c. demagnetizing or magnetizing field). At no load the generated e.m.f. is evidently proportional to the effective field flux, ϕ_1 (Fig. 1), set up by the d-c. excitation; at loads, however, besides compensating for the ohmic drop, we have to take into consideration the reactance drop, due to self-induction caused by

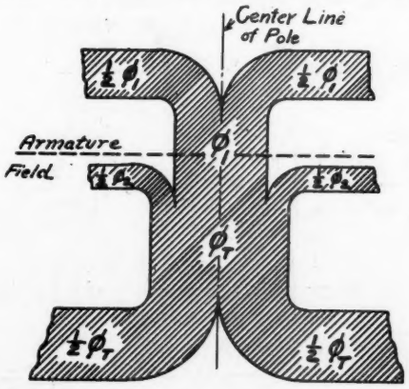


Fig. 1.

the a-c. leakage field, ϕ_3 (Fig. 2), and also compensate for the demagnetizing or magnetizing effect of the a-c. current caused by the field ϕ_4. Such action of the current, even if it is alternating, is evidently possible, because the main field has changed into a field of reversed polarity in the same time element that it takes the armature current to reverse.

It is the object of this article to investigate, analyze and determine the field leakage, ϕ_2 (Fig. 1), which takes place between the poles of a synchronous machine of the defined pole con-

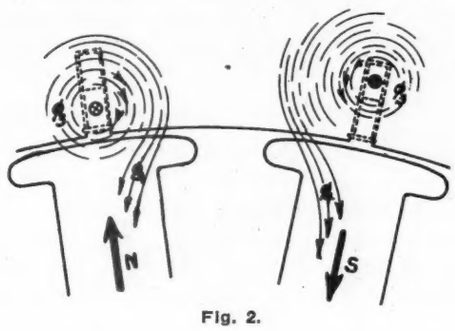


Fig. 2.

struction, this leakage being caused by the excitation and depending upon it, as well as upon the structural design of the machine.

In the Feb. 17, 1917, issue of ELECTRICAL REVIEW there appeared an article by the writer which gave a simple method for calculating the effective flux per pole, which, taking into consideration both the field form and the e.m.f. wave form, is very accurate.

It was found for the effective flux per pole:

$$\phi_1 = \frac{\phi_{total} \times C_p}{2p}$$

Where ϕ_1 = Flux per pole in Kapp lines (1 Kapp line = 6000 maxwells)

ϕ_{total} = Total maximum flux (Kapp lines), i. e., maximum flux density (Kapp lines) under the pole in the air gap times the total surface of the armature in square inches.

$$= \frac{E \times 10^6}{C_w \times f_c \times N \times \text{R.p.m.}}$$

E = Effective terminal voltage.

C_w = Winding constant, which depends on form factor, spread factor, pole constant, phase and connection.

f_c = Chord factor, depending upon throw of armature coil.

N = Total number of effective conductors.

R.p.m. = Revolutions per minute.

C_p = Pole constant, as found from the field form.

$2p$ = Number of poles.

From the above equations the correct magnetic

densities may be found for the air gap, the teeth and the armature core. For the pole and spider, however, it is necessary to know the leakage flux, ϕ_2, and as this flux varies approximately from 10 to 50% of the effective flux, depending upon speed, capacity and structural design, it is obviously important to determine it accurately.

Similar to the ohmic law, there exists the following relation between m.m.f., flux and reluctance:

$$\text{m.m.f.} = \text{Flux} \times \text{reluctance.}$$

$$\text{m.m.f. per pole} = 0.4\pi\,(AT_d + AT_t + AT_c)$$

$$= 0.4\pi \times \Delta_p$$

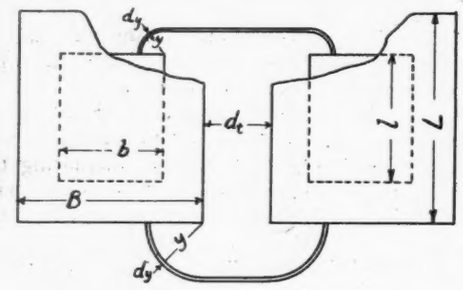
AT_d = Ampere turns necessary for sending the effective flux through the effective air gap. (Effective air gap = mechanical clearance between center of pole and armature + an increase due to the armature slots.)

AT_t = Ampere turns for the teeth.

AT_c = Ampere turns for the armature core.

m.m.f. between pole tips $= 0.4\pi \times 2\Delta_p$.

Now we distinguish between four different leakage paths and leakages as follows (the method adopted here is a modification of that pro-



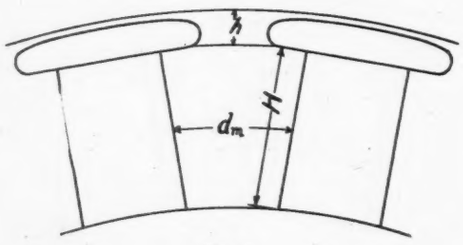


Fig. 3.

posed by Prof. E. Arnold and J. L. La Cour in "Die Wechselstrommachinen"):

ϕ_{L_1} = Pole tip side leakage.

ϕ_{L_2} = Pole tip end leakage.

ϕ_{L_3} = Pole body side leakage.

ϕ_{L_4} = Pole body end leakage.

As the method employed is slightly different for low and high-speed machines, we will first investigate the field leakage for low-speed machines, or machines having relatively many poles, with pole sides of adjacent poles more or less parallel (Fig. 3).

The leakage flux between pole tip sides will be

$$\tfrac{1}{2}\phi_{L_1} = \frac{\text{m.m.f. between pole tips}}{\text{magnetic reluctance of leakage path}}$$

$$= \frac{\text{m.m.f.}}{\Omega_1}$$

$$= \frac{\dfrac{0.4\pi \times 2\Delta_p}{d_t}}{\dfrac{h \times L}{}} = \frac{0.4\pi \times 2\Delta_p \times h \times L}{d_t}$$

Introducing Kapp lines and inches instead of maxwells and centimeters, we obtain:

$$\tfrac{1}{2} \times 6000\,\phi_{L_1} = \frac{0.4\pi \times 2\Delta_p \times h \times L}{d_t} \times 2.54$$

$$\tfrac{1}{2}\phi_{L_1} = \frac{2.54 \times 0.4\pi}{6000} \times \frac{\Delta_p \times 2 \times h \times L}{d_t}$$

$$= \frac{\Delta_p}{1880} \times \frac{2 \times h \times L}{d_t}$$

and $$\phi_{L_1} = \frac{\Delta_p}{1880} \times \frac{4 \times h \times L}{d_t} \text{ (Kapp lines)}$$

The pole tip end leakage will be:

$$\tfrac{1}{4}\phi_{L_2} = \frac{\text{m.m.f.}}{\Omega_2} = \int_{Y=0}^{Y=B/2} \frac{0.4\pi \times 2\Delta_p}{\dfrac{d_t + (\pi \times Y)}{h \times d_Y}}$$

$$= \int_{Y=0}^{Y=B/2} \frac{0.4\pi \times 2\Delta_p \times h \times d_Y}{d_t + (\pi \times Y)}$$

$$= 0.4\pi \times 2\Delta_p \times h \int_{}^{Y=B/2} \frac{d_Y}{d_t + \pi_Y}$$

Or, using Kapp lines and inches:

$$\tfrac{1}{4}\phi_{L_2} = 2 \times \frac{\Delta_p}{1880} \times h \int_{Y=0}^{-B/2} \frac{d_Y}{d_t + \pi_Y}$$

$$\int_{Y=0}^{Y=B/2} \frac{d_Y}{d_t + \pi_Y} = \frac{1}{\pi}\left[ln\,(\pi \times Y + d_t)\right]_0^{B/2}$$

$$= \frac{1}{\pi}\left[ln\left(\frac{\pi \times B}{2} + d_t\right) - ln\, d_t\right]$$

$$= \frac{1}{\pi}\, ln \frac{\pi \times B/2 + d_t}{d_t} = \frac{1}{\pi}\, ln\left(1 + \frac{\pi B}{2d_t}\right)$$

Now:

$$ln\, X = \frac{1}{0.434} \log X = 2.3 \log X$$

And we obtain:

$$\tfrac{1}{4}\phi_{L_2} = 2 \times \frac{\Delta_p}{1880} \times h \times \frac{1}{\pi} \times 2.3 \log \left(1 + \frac{\pi B}{2d_t}\right)$$

Or:

$$\phi_{L2} = \frac{\Delta_p}{1880} \times \frac{4 \times 2 \times 2.3}{\pi} \times h \log\left(1 + \frac{\pi B}{2 \times d_t}\right)$$

$$= \frac{\Delta_p}{1880} \times 5.86 \times h \times \log\left(1 + \frac{\pi B}{2 \times d_t}\right)$$

POLE BODY SIDE LEAKAGE.

$$\tfrac{1}{2}\phi_{L3} = \frac{\text{m.m.f.}}{\Omega_3}.$$

At the bottom of the pole, m.m.f. = 0.
At the top of field coil m.m.f. = $0.4\pi \times 2\Delta_p$.

$$\text{Average m.m.f.} = \frac{0.4\pi \times 2\Delta_p}{2} = 0.4\pi \times \Delta_p.$$

If d_m (Fig. 3) is taken as the mean length of reluctance path, then:

$$\Omega_3 = \frac{d_m}{l \times H}$$

We have:

$$\tfrac{1}{2}\phi_{L3} = \frac{0.4\pi \times \Delta_p \times l \times H}{d_m}$$

And using Kapp lines and inches:

$$\tfrac{1}{2}\phi_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times H}{d_m}$$

Or:

$$\phi_{L3} = \frac{\Delta_p}{1880} \times \frac{2 \times l \times H}{d_m}$$

POLE BODY END LEAKAGE.

Similar to pole tip end leakage we have:

$$\tfrac{1}{4}\phi_{L4} = \frac{\text{m.m.f.}}{\Omega_4}$$

$$\text{m.m.f.} = 0.4\pi \times \frac{0 + 2\Delta_p}{2} = 0.4\pi\Delta_p$$

$$\Omega_4 = \frac{d_m + \pi_Y}{H \times d_Y}$$

$$\tfrac{1}{4}\phi_{L4} = \int_{y=0}^{y=b/2} \frac{0.4\pi \times \Delta_p \times H \times d_Y}{d_m + \pi_Y}$$

$$= 0.4\pi \times \Delta_p \times H \int_{y=0}^{y=b/2} \frac{d_Y}{d_m + \pi_Y}$$

$$= 0.4\pi \times \Delta_p \times H \times \frac{1}{\pi} 2.3 \log\left(1 + \frac{\pi b}{2 d_m}\right)$$

And using Kapp lines and inches:

$$\phi_{L4} = \frac{\Delta_p}{1880} \times 2.93 \times H \times \log\left(1 + \frac{\pi b}{2 \times d_m}\right)$$

TOTAL LEAKAGE FLUX.

Referring to Fig. 1, the total leakage flux, ϕ_2, will be, in Kapp lines:

$$\phi_2 = \phi_{L1} + \phi_{L2} + \phi_{L3} + \phi_{L4}$$

$$= \frac{\Delta_p}{1880}\left[\frac{4 \times h \times L}{d_t} + 5.86 \times h \times \log\left(1 + \frac{\pi B}{2 d_t}\right) + \frac{2 \times l \times H}{d_m} + 2.93 \times H \log\left(1 + \frac{\pi b}{2 d_m}\right)\right]$$

$$\frac{\phi_2}{\phi_1} \times 100 = \text{field leakage in per cent.}$$

For high-speed machines or machines having comparatively few number of poles the assumption made, in case of slow-speed machines, that half the m.m.f. acts as $H/2$, with a mean length of leakage path, d_m, cannot be made, as the divergence of the poles then obviously must be taken into consideration.

The calculation of pole body side and end leakages will therefore be modified as follows:

Referring to Fig. 4, divide the height of pole H into several equal parts, say four (h_1, h_2, h_3 and h_4). Draw approximate mean leakage paths for these parts (d_{m1}, d_{m2}, d_{m3} *and* d_{m4}).

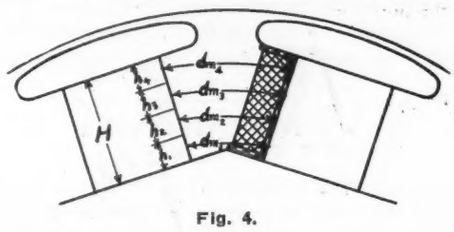


Fig. 4.

The pole body side leakage will be

$$\phi_{L3} = [\phi^{h1}{}_{L3} + \phi^{h2}{}_{L3} + \phi^{h3}{}_{L3} + \phi^{h4}{}_{L3}]$$

At the bottom of pole the m.m.f. = 0; at the top of the first layer, however, the m.m.f. = $2 \times 0.4\pi \times \frac{1}{4}\Delta_p$; the average m.m.f. of h_1 part of the pole is, therefore, $0.4\pi \times \frac{1}{4}\Delta_p$, and acting with a mean length of leakage path = d_{m1}, we have:

$$\tfrac{1}{2}\phi^{h1}{}_{L3} = \frac{0.4\pi \times \frac{1}{4}\Delta_p \times l \times h_1}{d_{m1}}$$

Or, using Kapp lines and inches:

$$\tfrac{1}{2}\phi^{h1}{}_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times h_1}{4 d_{m1}}$$

In this case $h_1 = \frac{1}{4}H$, and we obtain:

$$\phi^{h1}{}_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times H}{8 d_{m1}}$$

At the bottom of the second layer, h_2, the m.m.f. = $2 \times 0.4\pi \times \frac{1}{4}\Delta_p$, and at the top the m.m.f. = $2 \times 0.4\pi \times \frac{1}{2}\Delta_p$. The average m.m.f. for h_2 part of the pole is therefore:

$$\frac{2 \times 0.4\pi \times \Delta_p(\frac{1}{2} + \frac{1}{4})}{2} = 0.4\pi\Delta_p \times \tfrac{3}{8} \times 2$$

The reluctance for this strip (h_2) of the pole is:

$$\frac{d_{m2}}{l \times H/4} = \frac{d_{m2} \times 4}{l \times H}, \text{ and we obtain:}$$

$$\tfrac{1}{2}\phi^{h2}{}_{L3} = \frac{0.4\pi \times \Delta_p \times 3 \times l \times H \times 2}{d_{m2} \times 4 \times 8}$$

which equation, expressed in Kapp lines and inches, will give:

$$\phi^{h2}{}_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times H}{d_{m2}} \times \tfrac{3}{8}.$$

In a similar way we obtain for part (h_3) of the pole:

$$\phi^{h3}{}_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times H}{d_{m3}} \times \tfrac{5}{8}$$

And:

$$\phi^{h4}{}_{L3} = \frac{\Delta_p}{1880} \times \frac{l \times H}{d_{m4}} \times \tfrac{7}{8}$$

The pole body end leakage will be:

$$\phi_{L4} = [\phi^{h1}{}_{L4} + \phi^{h2}{}_{L4} + \phi^{h3}{}_{L4} + \phi^{h4}{}_{L4}]$$

For $\phi^{h1}{}_{L4}$ we have:

m.m.f. $= 0.4\pi \times \tfrac{1}{4}\Delta_p$

Reluctance $\dfrac{(d_{m1} + \pi_Y) \times 4}{H \times d_Y}$

$$\tfrac{1}{4}\phi^{h1}{}_{L4} = \int_{Y=0}^{Y=b/2} \frac{0.4\pi \times \Delta_p \times H \times d_Y}{(d_{m1} + \pi_Y) \times 4 \times 4}$$

$$= \frac{0.4\pi \times \Delta_p \times H}{16} \int_{Y=0}^{Y=b/2} \frac{d_Y}{d_{m1} + \pi_Y}$$

or $$\phi^{h1}{}_{L4} = \frac{0.4\pi \times \Delta_p \times H}{16} \times 4 \times \frac{1}{\pi} \times 2.3 \log\left(1 + \frac{\pi b}{2d_{m1}}\right)$$

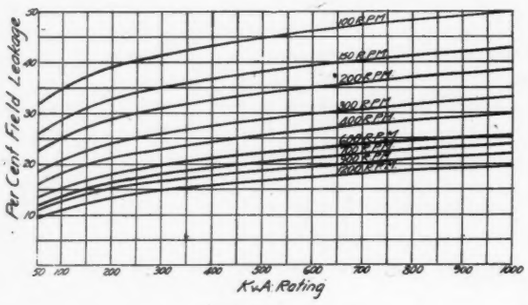


Fig. 5.

And, using Kapp lines and inches:

$$\phi^{h1}{}_{L4} = \frac{16}{2.93} \times H \times \log\left(1 + \frac{\pi b}{2d_{m1}}\right) \times \frac{\Delta_p}{1880}$$

$$= 0.183 \times H \log\left(1 + \frac{\pi b}{2d_{m1}}\right) \times \frac{\Delta_p}{1880}$$

In a similar way we obtain:

$$\phi^{h2}{}_{L4} = 0.183 \times H \times 3 \log\left(1 + \frac{\pi b}{2d_{m2}}\right) \times \frac{\Delta_p}{1880}$$

$$\phi^{h3}{}_{L4} = 0.183 \times H \times 5 \log\left(1 + \frac{\pi b}{2d_{m3}}\right) \times \frac{\Delta_p}{1880}$$

$$\phi^{h4}{}_{L4} = 0.183 \times H \times 7 \log\left(1 + \frac{\pi b}{2d_{m4}}\right) \times \frac{\Delta_p}{1880}$$

The total leakage flux in Kapp lines (Φ_2) for high-speed machines will be:

$$\phi_2 = \phi_{L1} + \phi_{L2} + \phi^{\Sigma h}{}_{L3} + \phi^{\Sigma h}{}_{L4}$$

$$= \frac{\Delta_p}{1880}\left[\frac{4 \times h \times L}{d_t} + 5.86 \times h \times \log\left(1 + \frac{\pi b}{2d_t}\right) + \frac{Hl}{8}\left(\frac{1}{d_{m1}} + \frac{3}{d_{m2}} + \frac{5}{d_{m3}} + \frac{7}{d_{m4}}\right) + 0.183\, H\left[\log\left(1 + \frac{\pi b}{2d_{m1}}\right) + 3\log\left(1 + \frac{\pi b}{2d_{m2}}\right) + 5\log\left(1 + \frac{\pi b}{2d_{m3}}\right) + 7\log\left(1 + \frac{\pi b}{2d_{m4}}\right)\right]\right]$$

Fig. 5 gives approximate per cent field leakage of modern 60-cycle synchronous machines of various capacities and speeds.

MOVEMENT TO CREATE TEXAS PUBLIC UTILITIES COMMISSION.

In an effort to obtain the enactment by the Texas legislature of a public utilities law that will meet the support or endorsement of various interests concerned, Governor W. P. Hobby has appointed a committee to draft the proposed bill which will be submitted at the next regular session of the legislature in January, 1921. The League of Texas Municipalities, which is composed of the mayors and other officials of the different cities and towns of the state, is back of the movement to create a public utilities commission. The committee appointed by Governor Hobby to prepare the bill is composed of prominent Texans, among whom are the following: Mayors Frank W. Wozencraft of Dallas, J. W. Chancellor of Bowie and E. A. Amerman of Houston, representing the cities; Charles A. Harty, W. B. Head and J. D. Frank, all of Dallas, representing the public utilities. It is expected that the committee will soon hold a meeting for organization.

NEW YORK CENTRAL-STATION COMPANIES CONSOLIDATE.

A charter has been issued to the Fulton County Gas & Electric Co., which was formed by the consolidation of the Fulton County Gas & Electric Co. with the Mohawk Hydro-Electric Co. The company's principal office is at Gloversville, N. Y. Their capital amounts to $1,732,600, consisting of 10,300 shares of 8% cumulative first preferred, 1276 shares of 6% second preferred, and 5750 shares of common stock. Par value of all classes is $100. The company will operate in the counties of Fulton, Herkimer, Montgomery, Otsego, Schenectady and Schoharie. Among the directors are Lucius H. Littauer, New York; Walter Clark, Philadelphia, and James C. Delong, Syracuse, N. Y.

Survey of Existing Coal-Shortage Situation

Estimate of Coal Needs for the Year—Figures Showing Past and Present Monthly Bituminous Coal Production—Use of Coal for Exportation, Domestic Service, by Utilities and Other Industries

Present developments point to a brighter future in the coal situation than had been previously anticipated. The American Wholesale Coal Association, through George H. Cushing, its managing director, has steadily maintained that there was no coal shortage, but that there was a serious case of bad coal distribution. The National Coal Association, the coal producers' organization, has not been so optimistic. Short production has been attributed to a lack of cars, the producers contending that coal enough would be available if cars could be secured and transported. At the present time the National Coal Association takes a much more optimistic view of the situation. The following statement by John B. Pratt, director of publicity for the association, prepared especially for ELECTRICAL REVIEW, gives a general analysis of the entire situation:

"In general, the situation at the present time is greatly improved. There is every prospect that the acute coal shortage, which has existed since April 1, will be made up and that the danger of a shortage next winter is over. The whole difficulty having to do with the coal emergency has been due entirely to lack of car equipment at the mines. With the average car supply running only from 25 to 50% of normal at the majority of mines throughout the bituminous fields, the operators, up until the last two weeks or so, had been unable to meet the country's requirements for coal.

COUNTRY STILL SUFFERING FROM RESULTS OF STRIKES.

"The whole nation is still suffering from the effect of the strike of miners in the bituminous fields last winter. This strike, which lasted six weeks, forced the country to use up all of its reserve stocks of soft coal. At the beginning of the coal year, April 1 last, there was a deficiency in coal supply, inherited from the strike, of some 15,000,000 tons. Not alone were the operators faced with the prospect of having to make up this shortage, but, with an unusual demand on the part of industries which had resumed operation after having been closed down since the signing of the armistice, an unusual output was required from the mines if the entire wants of the country were to be met. It is estimated that a shortage in supply of some 30,000,000 tons existed early in the summer.

"To give the country all the soft coal it will want during the year ending April 1 of next year, experts have estimated that there must be a production of 545,000,000 tons. Up to July 1 approximately 258,000,000 tons had been produced, which would bring the aggregate for 12 months, if the same ratio were maintained, up to 516,710,000 tons. This would fall short 29,000,000 tons of the minimum estimated requirements of the country.

"Only by running the mines at an output of 12,000,000 tons a week, it is estimated, from now until the end of December, 1920, can the shortage be made up. The average weekly production up to Aug. 1 was just a trifle over 10,500,000 tons. It was then running more than 1,200,000 tons below the weekly requirements necessary to save the country from a coal shortage during the winter."

STEPS TAKEN TO RELIEVE THE STRAIN OF EXISTING COAL SHORTAGE.

Efforts to relieve the situation above described were initiated early in April and, after numerous hearings, resulted in the issuing of priority orders by the Interstate Commerce Commission. The following analysis by Mr. Pratt shows what these orders are aimed to accomplish:

"These priority orders comprehend the obligation on the part of railroads to place 4000 cars a day at mines supplying the Northwest and to unload these cars at lake ports daily for transshipment to northwestern ports on the lakes. This involves the dumping of 200,000 tons of coal a day at the Great Lakes piers, or 1,200,000 tons a week for a period of 100 days ending with the close of navigation, which comes early in December.

"As to New England, the priority order involves shipments of coal to tidewater ports averaging 1,250,000 tons a month for trans-shipment by vessel to New England ports. This tidewater movement, it is comprehended, will be augmented by a supply of approximately 700,000 tons of coal a month shipped by rail direct to New England from the mines. With these two movements, the tidewater and all rail, New England would have 2,000,000 tons of coal a month up to Dec. 1 after which, it is believed, the shipments could be materially reduced.

"According to advices received by the National Coal Association, which represents operators with over two-thirds of the bituminous coal output of the country, there is every prospect that the shipments of coal to the Great Lakes will be sufficient to meet the demands. Up to the end of this week there has been a marked improvement in the movement of coal to tidewater, with every expectation that the railroads will carry out the schedule fixed for them. As to New England, the program has already been put into effective working force by the railroads in movements of coal to tidewater so that the average weekly quota is now being dumped.

"The remedy that needed to be applied to eliminate the coal shortage emergency, therefore, has already been applied and gives every indication of being effectively worked out. It is all a matter of the supply of cars at the mines. That has been the situation since April 1, and it will be the situation until all the coal that the country needs is moved from the mines.

"The recent strike of Illinois and Indiana miners had the effect of shutting off some 1,800,000 tons of coal output, a part of which would have gone to the Great Lakes piers. However, this shortage can be made up if the miners stick at their work and the railroads fulfill their obligation as to the daily percentage of cars to be supplied at the mines under the priority schedule."

TABLE NO. 1.—TOTAL COAL PRODUCTION IN THE UNITED STATES.

Year.	Bituminous. net tons.	Anthracite. net tons.	Total. net tons.
1913	478,434,000	91,525,000	569,960,000
1914	422,704,000	90,822,000	513,525,000
1915	442,626,000	88,995,000	531,619,000
1916	502,520,000	87,578,000	590,098,000
1917	551,791,000	99,612,000	651,402,000
1918	579,386,000	98,826,000	678,211,000
1919	458,063,000	86,196,000	544,259,000
1920*	535,000,000	.....	.....
1920**	545,000,000	.....	.....

*Estimate by American Wholesale Coal Association.
**Estimate by National Coal Association.

In order that a general view of the entire situation may be had, a number of tables are presented showing various phases of the coal situation. Table No. 1 shows the coal production by years for the past seven years together with the estimated needs of the present year. It will be noted that the two separate estimates given are quite close together, the differences being less than 2%. The estimates are less than the production of 1917 or 1918 but greater than that of 1919. During 1919 the production was curtailed by strikes to the extent of probably 25,000,000 tons, this shortage and others being partly compensated for by a reduction of about 40,000,000 tons in the amount of coal in storage. From this it seems evident that the estimates are not far from representing the actual needs.

Table No. 2 has been arranged to show how this year's production compares with that of 1916 and 1917. Examination of Table No. 1 will show that the production for 1917 was just a little in excess of that estimated for 1920, and the production of 1916 was somewhat less than that estimated for 1920. Examination of Table No. 2 shows that the production so far this year is being carried on at a considerably higher rate than in 1916, but at a lower rate than prevailed in 1917. Under the more favorable transportation conditions existing at the present time the production for the remainder of the year should be sufficient to make up any existing actual shortage. However, erratic buying, or future difficulties not now evident, might still cause inconvenience to certain coal users.

TABLE NO. 2.—COMPARISON OF BITUMINOUS COAL PRODUCTION FOR FIRST SEVEN MONTHS OF 1916, 1917 AND 19120.

	1916, net tons.	1920, net tons.	1917, net tons.
January	46,596,000	48,689,000	47,967,000
February	45,187,000	40,127,000	41,353,000
March	43,827,000	46,792,000	47,869,000
April	33,628,000	37,939,000	41,854,000
May	38,804,000	39,753,000	47,086,000
June	37,742,000	44,500,000*	46,824,000
July	38,113,000	45,511,000*	46,292,000

*Subject to revision.

As an indication of the importance of the export coal trade on the coal situation, it may be noted that the entire coal export for the year 1917 amounted to less than 32,000,000 tons including foreign-trade bunker coal. Export coal for 1918 and 1919 totaled less than 29,000,000 tons for each year. The total export for the first half of 1920, including foreign-trade bunker coal, amounted to a little over 18,000,000 tons. From this it is evident that the coal export for the current year will be somewhat in excess of that of previous years, but should not total an increase of more than 1 or 2% of the year's production.

The coal consumption of public utilities amounts to only about 40,000,000 tons per year, electric utilities using about 35,000,000 tons and gas utilities about 5,000,00 tons. By-product coke, beehive coke and domestic usage each require about the same quantity of coal as the utility companies. Railroads require about four times as much coal as utilities, and industrial plants require about five times as much.

These figures show that the utility companies are but a small factor in the coal market of the country. Figures previously given show that in all probability there will be plenty of coal produced in this country to meet all the legitimate needs. Under the existing circumstances it seems evident that the chief concern of the utility company is to see that coal at a reasonable cost is delivered for service rather than being held in someone's yard in anticipation of a crisis that should not materialize. A reasonable storage of coal in accordance with the seasonal supply and usage is proper and indicates good planning, but a hoarding of coal for an impending shortage does not seem to be justified and will only tend to bring on such a shortage by distorting the relation between need and demand.

Considering the great service rendered by utilities, it seems evident that they are justified in demanding that provision be made for their requirements out of the supply of fuel that is available. Their requirement is small, but the inconvenience, suffering and loss that would result from their failure would be almost beyond calculation.

EXECUTIVE COMMITTEE OF N. E. L. A. TO MEET IN NEW YORK CITY.

Announcement has been made that the executive committee of the National Electric Light Association will meet Sept. 1 at the national headquarters in New York City. The chairmen of the four national sections—accounting, commercial, public relations and technical—will outline the programs of their particular sections for approval of the executive committee. The presidents of the geographic divisions, or their representatives, are expected to be present with complete budgets covering the expenses of proposed activities for the ensuing year, in order that these may be passed upon by the executive committee. Announcements of additional national standing and special committees will be made by President Martin J. Insull at that time.

Record of Large Turbogenerator Armature Breakdowns*

Statement Giving an Analysis of Causes of Armature Failures in Large Westinghouse Generators—Majority of Failures Found Due to Operating Hazards Originating Outside of Generators

By F. D. NEWBURY

Manager, Power Engineering Department, Westinghouse Electric & Manufacturing Co.

The following statement is a complete record of armature breakdowns that have occurred in Westinghouse turbogenerators of 15,000-kv-a. or larger polyphase rating. The record covers every Westinghouse turbogenerator of this size that had been placed in operation up to January, 1920. These generators, without exception, are mica insulated, with mica insulation between strands and between conductors as well as between coil and core.

The first Westinghouse generators larger than 10,000 kv-a. were placed in operation in 1913. These were generators, roughly 20,000 kv-a. in size, two-pole in the case of 25 cycles, and four-pole in the case of 60 cycles. The design of such large two and four-pole units in 1911 and 1912 was highly experimental, and while these units met the standard temperature rise guarantee of 50 deg. C. by thermometer it has since been found that the true copper temperatures of the strands nearest the air gap near the center of the core have been at least 200 deg. C. rise in some cases. Experience has shown designers how to avoid these high local temperatures to a considerable degree (mainly by reduction of eddy-current losses), and this is mentioned here only to bring out the significance of the record of trouble due to heating.

It is also important to note the inclusive and representative nature of the record. It covers all generators built of a given size and type and it is therefore safe to draw general conclusions that will be applicable to all generators of the same class.

During these seven years of experience there have been 22 cases of major armature trouble involving 12 different installations or designs and 16 individual units. By major armature trouble is meant trouble serious enough to result in the failure of one or more armature coils.

Responsibility for Failure Used as Basis for Classification.

The classification of armature failures as to cause is in some cases a difficult matter. The events leading up to the trouble may be unknown and the evidence is very often burnt up. It has been thought best, therefore, to separate these cases into three classes as follows

1. Where the manufacturer has accepted responsibility.
2. Where the operating company has accepted responsibility.
3. Where the cause is unknown or in dispute.

Assigning Causes of Failure.

1. Eight cases were chargeable to design, workmanship or other causes for which the manufacturer accepted responsibility.

   (a) Five cases (of these eight) were caused by defects in manufacture that developed shortly after installation.

   (b) Three cases (of these eight) concerned details of design that led to failure after four or five years' operation. Two of these cases (in one design) involved high local temperatures caused by eddy currents in the top strands of the coil.

2. Eleven cases were chargeable to operating hazards for which the operating company accepted the responsibility.

   (a) Four cases (of these 11) were caused by fire originating outside of the armature winding. In three of these cases the fire started in the cables just outside of the generator; in the fourth case the fire started in a series transformer accidentally open-circuited.

   (b) Four cases (of these 11) occurred in one installation and were caused by abnormal voltage surges that caused the outside surfaces of the insulation to catch fire. In addition to these four cases that resulted in coil failures, as many more fires started that were put out before such damage was done. This trouble disappeared after the generator neutral was grounded.

   (c) One case (of these 11) was caused by ice or water carried into the generator from the air washer.

   (d) Two cases (of these 11) were caused by enforced operation under conditions that were known to be unsafe. One case involved unsafe overloads and the other case involved continued operation after it was known that the armature needed minor repairs.

3. Three cases involved unknown causes or the cause was in dispute. In two of these cases the operating company believed armature-coil heating to be responsible.

This classification of armature breakdowns shows that out of 19 cases, where causes were agreed to, 11 cases were caused by operating hazards for which the generator can in no way

*This article is based on a discussion of a paper, "Classification of Large Steam Turbogenerator Failures," by Philip Torchio, presented before the American Institute of Electrical Engineers at White Sulphur Springs, June 30, 1920.

be held accountable. The majority of these cases were caused by fires of external origin.

If all the cases in which armature heating was involved (even by suspicion) are grouped, there are only five cases out of 22 breakdowns. Two cases (involving one of the first designs) were caused by design proportions; in two others temperature was not the primary cause of breakdown, but the operating companies believed it to be a contributory cause, and in the fifth case enforced overloading was the primary cause.

Armature Heating Failures Caused By Abnormal Local Temperatures.

The writer's opinion, based on a careful study of operating experience and based on a detailed knowledge of internal temperatures and coil and insulation design, is that breakdowns caused by armature heating are in reality due to abnormal local temperatures that have values of the order of several hundred degrees; and that temperatures of 100 deg. or 150 deg. C. ordinarily discussed in connection with guarantees have very little to do with the problem. This statement, of course, applies only to windings completely insulated with mica within the slots.

This record of breakdowns brings to the surface another fact that is interesting and important and that is reassuring to the companies operating high-voltage units. If these generators be classified according to voltage it is found there are twice as many generators wound for 11,000 volts or higher voltage as there are generators wound for lower voltages. But these 22 cases of armature breakdown are equally divided between these two voltage classes. This means that the percentage of armature breakdowns in the high-voltage generators under discussion is only one-half that of the lower-voltage generators. This record would be very different with treated-cloth insulation (in large high-voltage generators) that is subject to cumulative heating on account of dielectric losses increasing with temperature, or with partially closed armature slots still used by some European designers.

High-Voltage Probably More Reliable than Low-Voltage Generators.

This record does not prove that high-voltage generators are necessarily safer or less subject to breakdown, except in so far as breakdowns may be caused by voltage surges that are independent of generator voltage. Obviously a 10,000-volt surge would be dangerous in a 2400-volt generator, but would be harmless in a 13,000-volt winding. The record does prove that 11,000 and 13,000-volt windings are just as reliable as low-voltage windings and that breakdowns are generally caused by trouble unrelated to line voltage.

The facts brought out by this record may be summarized as follows:

1. The majority of armature breakdowns are caused by operating hazards originating outside the generator.

2. Armature heating in armatures completely insulated with mica is a minor cause of breakdown.

3. High-voltage generators, with mica insulation and open armature slots, are as reliable and probably are more reliable than large low-voltage generators.

HYDROELECTRIC POSSIBILITIES BEING DEVELOPED BY ITALY.

Since the signing of the armistice Italy has resumed her industrial life with considerable rapidity. She has not been free from the uncertainties of radical political action, but there is every evidence that these are on the decline; Italy is at work as completely as any nation in Europe and more so than most of them. Her wealth in hydroelectric possibilities is being developed at a rapid rate. Energy for industrial purposes, while absorbed as quickly as it is produced, is extremely cheap, and in a few years it will be abundant and the whole country interlaced with transmission lines. The various companies engaged in this work are well financed and are working harmoniously in both plant and line extensions. The men engaged in this business are young, energetic and capable business men, highly representative of the new spirit that has possessed the industrial life of the country. The electrification of the Italian railways now proceeding involves 4000 miles of additional trackage. The cost of the energy is not so great a problem as the cost to the government of converting the necessary equipment, but the mileage already converted is considerable and the equipment is of a very high order.

WOMAN MAKES LIVING THROUGH USE OF VACUUM CLEANER.

At least one capable woman in England has discovered the possibilities of the electric vacuum cleaner in earning an independent living. According to Miss F. Alexander, of Earl's Court, London, Eng., any intelligent woman can earn $1000 a year and upward by carrying on an electric vacuum cleaner service in any large community. Miss Alexander started her work during the world war. She wheels her own cleaner from house to house and is overwhelmed with orders. Her charges average about $5 a day, with a substantial reduction for regular fortnightly or monthly service. Suitable cleaners for this class of work cost about $100, which capital outlay is soon recovered and with average care in handling and maintenance the wear and tear is small. In these days of servantless homes such a service would undoubtedly be welcomed by many housewives.

EMPIRE STATE ASSOCIATION WILL MEET NEXT MONTH.

The annual meeting of the Empire Gas and Electric Associaton will be held at Utica, N. Y., Oct. 7-8, with headquarters at the Hotel Utica. The committee in charge of the meeting has not completed its program but announces that it will consist of papers and discussion of particular interest and value to companies operating in small communities. The annual dinner of the association will be held on the evening of Oct. 7. A meeting of the electric meter section of the association, scheduled to be held in Rochester, N. Y., Aug. 27, has been postponed until a date to be selected after the October meeting, as meter testing is one of the subjects to be discussed at that time. C. H. B. Chapin, 29 West 39th street, New York City, is the secretary of the association.

EDITORIAL COMMENT

Looking Ahead

It is not always that the engineer sees clearly and apprehends the meaning of great principles and forces beyond the immediate end of his professional duties. But all great engineers are possessed of the broad understanding and the imaginative faculty—controlled, it is true, by some judgment and common sense—without which true progress in the engineering world would hardly be possible.

We all know the small engineer—the man of average ability who understands the nature of the work he is engaged upon and performs it to his own and frequently to his employers' satisfaction. The great engineer is less common; he is of necessity a cultured man, with far-reaching interests and sympathies, and an understanding of men and things which, if it may be defined as applied or digested knowledge, must never be confused with accumulated knowledge. He is a person of enormous value to the community, but, since his virtue resides in his powers of vision and performance rather than those of oratory and leadership, he is rarely sought by the people or encouraged by politicians to take part in the government of his country. There have been notable exceptions, and it is needless to mention names in order to prove that great engineers are capable of serving their country wisely and well when occupying important administrative positions in the government. It is unfortunate also that there are certain aspects of a political career which do not commend themselves to the best type of engineer.

These thoughts have been suggested by a perusal of the discussion on the super-power system for the Northeast Atlantic seaboard. Here we find not perhaps anything of great value in the way of contributions to the manner in which certain engineering problems are to be attacked and solved, but rather an atmosphere of broad, far-reaching dreams and policies which carries us into the future and suggests the possibility of great attainments where the object sought is the better and more economical adaptation of the forces of nature to the service of man.

The small voice of the interested individual striving for some petty end that he or his associates may derive benefit therefrom, as well as the larger voice of the speaker who has nothing to say, appear to be absent from this discussion, and in their place we listen to the statements of men who are thinking along broad lines and are working for one common end. This end is not the establishment of this or that system, or this or that device as pre-eminently superior to all others, but the provision and interconnection of vast power systems in such a manner as will utilize with the minimum of waste the natural resources of the country. The reading of this account of an important session is as refreshing and invigorating as the salt-laden breezes of that Atlantic seaboard for which great minds are planning great and far-reaching developments.

The Coal Situation as Affecting Central Stations

Coal, the raw material of the central-station industry, still holds the active attention of almost every industrial and utility manager in the country. The immediate past has held rather grave prospects for some sections of the country, particularly New England and the Northwest, where the bulk of the season's supply of coal must be delivered by boat before the close of navigation. Regardless of the cause of the situation threatened, attributed to various causes by different authorities, it seems evident that the needed coal will be delivered to these isolated districts.

One set of authorities has contended that the districts in distress were neglected because of the lack of transportation equipment, while other authorities have contended that the coal was not supplied because the consumers, or their representatives in the coal trade, would not pay the price demanded. So far as the public utility companies are concerned the reasons advanced are immaterial. Failure of the coal supply because of a lack of railroad cars would shut down a utility plant no more quickly or effectively than the bankruptcy of the company resulting from its inability to pay an excessive price for fuel.

With the selling price of electric power fixed by law, the return to the central-station company derived from the burning of a ton of coal is almost a fixed and unvarying sum. An advance in the cost of fuel is accompanied by an almost equal proportional advance in the operating costs to produce a unit of power, the labor charges being small in proportion to the coal costs. The doubling of customary coal costs, as a rule, will wipe out all earnings for dividends and depreciation. With coal commanding prices of two, three or four times the usual amount, and with incomes fixed, the utilities of the country would face bankruptcy and be shut down just as surely

as if there were no cars to deliver their supply.

The utilities must operate. The consequences that would result from their failure are too great to allow any combination of conditions to accomplish their downfall. At the present time it is gratifying to note that the various interests are now practically agreed that coal enough will be provided for the various sections of the country. It is to be hoped that private enterprise will demonstrate its ability to handle the situation from now on without requiring further governmental action. However, with various agencies limiting the action of the utilities of the country, there is no alternative and the utilities must appeal to the national government—that is, to the people whom they serve—when fuel cannot be secured through private channels.

It is greatly to be hoped that the coal industry and the railroads of the country will see the situation as it actually is, and will make it their business to work out and carry through an effective plan that will care for the utilities. Regulation will not be needed if coal is provided at reasonable rates, but regulation is inevitable if the coal supply is shut off either for lack of transportation or for a failure of the coal industry to supply the needs at a fair price.

Preparing for Winter Operating Conditions

Is the power plant operating smoothly and carrying its load without signs of stress or weakness? It probably is at this time of year, but in a few weeks the days will begin to shorten and the engines, generators, boilers, stokers, etc., will commence to feel the approach of the long winter's run. There is time yet to overhaul that stoker which has not given a sign of trouble since it was out of service and generally repaired some months ago. There is also time to rebuild the bridgewall, repair the baffles, renew the arch, point up and paint the boiler settings, put a new set of brushes in the exciter, refinish the commutators, repair the plumbing and drainage systems and do the many other little odd jobs that will be demanding urgent attention before many weeks have passed.

Now is the time to attend to the details of repair that are sure to be required and that are so difficult to care for at a time when every available unit of steam and power are required of boilers and generators. With equipment suffering from minor ills and with a heavy and increasing load, the plant operator will have many trying hours to face before the next springtime brings relief. A thorough overhauling now will bring to light many little weaknesses that would result in breakages or shutdowns in the midst of the winter season of maximum demand. At the present time, when loads are light and equipment does not have to be crowded to its limit, many of the repairs can be done by the regular operating forces. But when the heavy demands come every operating man must be at his post and repairs must be made by outside help.

A few days' time and a few dollars spent now in examining and repairing equipment is the best and cheapest operating insurance available. Men will take pride in operating the plant and carrying the winter load if the equipment is in good condition, but are apt to lose interest and waste many dollars for the employer if required to tend a plant always on the verge of failure. Look the situation in the face, go after the plant from top to bottom, replace or renew all parts that will need attention before spring and you will be amply repaid in satisfaction and in money.

Engineers and Paternalism

It is interesting to note that the province of Alberta, Canada, has recently given official recognition to the profession of engineering through an enactment conferring upon those who qualify the title of "Registered Professional Engineer." Any civil, electrical, mechanical or mining engineer who is a resident of Alberta or other Canadian province, who has been practicing as a professional engineer for five years prior to the passage of the act, who is a member of the Association of Professional Engineers of Alberta or of a similar organization, or who can pass an examination before the duly authorized engineering council, is privileged to sign "R. P. E." after his name or otherwise advertise himself as a registered professional engineer. A penalty is provided for misuse of the title.

Among the engineers of the United States there is an occasional expression of desire on the part of a few who feel that some kind of governmental action would add to the dignity of the engineering profession. They feel that this dignity can best be legalized and protected from fraud or misrepresentation by some such legislation as that enacted by Alberta, Canada. But the idea has never received sufficient support in this country to reach the resolution or petition stage.

Here in the United States the engineering profession in all its branches has attained dignity and honor equal to if not greater than any other profession—and that, too, without legal enactment or any suffix other than that bestowed by the alma mater of each individual engineer. The engineers of the United States are, of course, no different from those of Canada, only that it seems our engineers are rather inclined to spurn paternalism and depend upon skill and individual dignity to maintain themselves and their profession in proper balance.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

UTILITIES COAL SUPPLY GAINS IN NEW YORK CITY.

Situation Is Improved Over Conditions of the Previous Week Although Some Companies Have Only Small Supply.

The Public Service Commission of New York has reported the weekly amount of coal on hand in reserve by the public utilities of New York City as follows: Brooklyn Rapid Transit Co, five days' supply; Interborough Rapid Transit Co., five days; Richmond Light & Railroad Co., two days; New York Steam Co., six days; New York Edison Co., including United Electric Light & Power Co., 21 days; Brooklyn Edison Co., Inc., 57 days; Queens Borough Gas & Electric Co., six days; Bronx Gas & Electric Co., 167 days; Kings County Lighting Co., 16 days; New York & Richmond Gas Co., four days; Consolidated Gas Co. system, 25 days; Brooklyn Union Gas Co., 21 days; Brooklyn Borough Gas Co., 43 days.

The report is dated Aug. 12 and shows a total among all the utilities for the first district of 259,807 tons of soft coal on hand as of that date. This is an increase of 25,013 tons over the previous week.

While this improvement is shown the situation is not yet by any means what could be desired, according to a statement from the office of the commission. The public-utility companies are fully 159,000 tons below the stocks they should have at this time of year. In order to pass through the winter with a safe margin the companies should have about 800,000 tons in stock on Oct. 1. To secure such a supply the rate of storage must be considerably increased.

S. E. D. URGES MANUFACTURERS TO CO-OPERATE WITH UTILITIES.

Suggests Program of Advertising in Effort to Gain Moral and Financial Support of Public to Utility Companies.

The Society for Electrical Development has sent a notice to electrical manufacturers calling their attention to the community of interests that exists between central-station companies and other branches of the electrical industry. It is pointed out that unless the utility companies gain the full moral and financial support of the public the electrical industry at large will suffer. It is realized that the advertising of most public utilities is local in its character, while that of electrical manufacturers is nation wide. One or two electrical manufacturers, notably the Western Electric Co., are using space in trade publications and national magazines to point out the necessity of public utilities securing the capital necessary to carry on their undertakings, and advocating the purchase of public utility securities to supply such funds.

It is felt that a great deal of benefit can be derived in this manner, and at a recent meeting of the executive committee of the Society for Electrical Development, General Manager J. M. Wakeman was instructed to bring the matter to the attention of the electrical manufacturers and to suggest that they devote a part of their advertising space to this important subject. The Society has undertaken the preparation of a number of sample advertisements that can be used for this purpose.

EDISON ILLUMINATING COMPANIES TO HOLD CONVENTION.

Program Will Be Featured by Discussion of Steam Turbines, Storage Batteries, Operating Problems, Electric Welding and Furnace Loads.

The thirty-ninth convention of the Association of Edison Illuminating Companies will be held at The Griswold, Eastern Point, New London, Conn., Sept. 13 to 16. President Walter H. Johnson has arranged a program which will be featured by discussion of steam turbines, storage batteries, operating problems, power-factor problems and electric-welding and furnace loads. There will also be reports from the Association's committees on standards, metering and service methods, electricity distribution and lamps.

The convention will be opened on Tuesday morning, Sept. 14, by the president's address, followed by the report of Treasurer Ernest A. Edkins. Next in order will be W. C. L. Eglin's report as chairman of the committee on standards, P. H. Bartlett's report as chairman of the committee on metering and service methods, and report of committee on electricity distribution and use by Chairman L. L. Elden. A paper on "Storage Battery Practice in Central-Station Service" by J. Lester Woodbridge will conclude the morning session.

At the evening meeting the following reports and addresses will be presented: Report of committee on steam turbines and generators by Chairman H. P. Liversidge; address on "Turbine Characteristics" by E. W. Rice, Jr.; address on "Problems of Synchronous Operation Arising From Use of Power-Limiting Reactors" by C. P. Steinmetz.

The sessions of Wednesday, Sept. 15, will be devoted to the following subjects: Symposium on system troubles, with introductory remarks by John W. Lieb; report of committee on symposium by Philip Torchio, chairman; troubles in generating stations: Baltimore, F. E. Ricketts; Boston, R. E. Dillon; Chicago, W. L. Abbott; Detroit, G. W. Cato; New York, W. H. Lawrence; Philadelphia, N. E. Funk; troubles on

direct-current distribution systems: Boston, L. L. Elden; Chicago, D. W. Roper; New York, Philip Torchio; Philadelphia, Thomas Sproule.

John W. Lieb, chairman of the lamp committee, will make a report at the evening session on Wednesday, followed by an address on "Central-Station Financing" by H. M. Addinsell, of Harris, Forbes & Co., after which there will be a general discussion of some of the principal factors in the industry. The proceedings will conclude with the showing of a film bearing the title, "Revelations."

On Thursday, Sept. 16, Alex. Dow, chairman of the committee on rates, will submit his report, and C. J. Russell will present a paper on "Commercial Aspects of Power-Factor, Its Measurement and Correction," the discussion on which will be opened by L. L. Elden and A. S. Knight. "Large Commercial Customer Problems" is the subject of a paper to be read by E. W. Lloyd, and C. F. Hirschfeld will talk on "Standard Methods of Handling Electric-Welding and Furnace Loads."

NEW ENGLAND SECTION, N. E. L. A., TO HOLD ANNUAL MEETING.

Program for Convention Includes Numerous Addresses and Papers on Variety of Subjects Interesting to Central-Station Men.

The New England Section of the National Electric Light Association will hold its annual convention at Kineo, Me., Sept. 13-16, with headquarters at the Mount Kineo House. The program will commence with an address by President C. R. Hayes, followed by M. H. Aylesworth, executive manager of the National Electric Light Association. Reports of the secretary, treasurer and various committees will then be submitted. A technical session will be held on the afternoon of Sept. 14, when committees of underground systems, electrical apparatus, overhead systems and prime movers will submit reports.

At Wednesday morning's meeting G. W. Hurn, chairman of the accounting committee, will make his report, in addition to which the following papers will be read: "Credits and Collections from a Public Service Company's Standpoint," by W. E. Dorsey; "The Importance of a Reliable Investment Account," by A. E. Lamb; "The Good-Will Value of an Efficient Accounting Organization," by I. S. Hall; "The Graphic Presentation of Statistics," by W. H. Blood, Jr., and "The Sale of Company Securities," by P. H. Whiting. A public policy session will be held in the evening, at which time several interesting talks will be heard, including one by Mr. Aylesworth on "What the N. E. L. A. Proposes to Do for Member Companies."

The session of Thursday, Sept. 16, will be devoted to commercial subjects, as follows: Commercial committee's report by Chairman R. D. Cutler; commercial relations division report by J. T. Day, chairman; contact committee report by William Gould, chairman. These will be followed by discussion led by W. F. Abely, representing the jobbers, J. E. Wilson, the contractors, and F. J. Allen, the manufacturers. R. E. Holden, chairman, will next submit his report for the merchandising division, and George H. Guest will speak on "The Fundamentals of Merchandising." The lighting division report will be submitted by C. A. Dean, chairman, and W. D'Arcy Ryan will give an illustrated lecture on "Industrial Lighting." In the afternoon the report of the ranges and water heating division will be presented by R. J. Patterson, and the power division report by V. M. F. Tallman, the meeting closing with a lecture by F. C. Hard, of Boston, "On Industrial Heating."

RESEARCH COMMITTEE TO INVESTIGATE COPPER INDUSTRY.

Use of Substitutes for Copper and Its Alloys Results in Formation of Committee to Restore Copper to Its Proper Field.

The wholesale way in which copper and its alloys have been crowded out of many of their legitimate fields of usefulness by substitutes of various kinds, brought into use during the war period, is responsible for the formation of a Copper and Brass Research Committee, the object of which is to ascertain the reason that copper is now in such an unenviable position commercially. The chairman of the committee is Walter Douglas, president of the Phelps-Dodge Corp., and the secretary is W. S. Eckert, vice-president of the National Conduit & Cable Co. Included in the membership of the committee are several other men prominent in the copper and brass industry, some of whom are connected with mining companies and some with mills. The committee has authorized Ivy L. Lee, 61 Broadway, New York City, to make a study of the situation.

The purpose of the study is to ascertain why copper, one of the most useful and important basic metals, is being replaced by other metals in many industrial uses. Were the substitute metals as satisfactory as copper or able to render the service that copper renders, the condition would not be unusual. But much of the substitute material is inferior to copper in many respects and is not much less expensive. In the long run, because of its resistance to corrosion, its permanence, strength, large salvage value and other desirable properties, copper is cheaper than most metallic substitutes. The investigation will attempt to determine the places in which copper has been used, the places in which it is used, the places in which its use has been discontinued, why it was discontinued, what the non-technical mind knows about copper as a material in industry, and other facts.

The scope of the investigation will be such as to include only the branches of industry from which copper is being crowded by the more militant substitutes. It is thought that there is no particular need to investigate conditions in those branches of industry in which copper is pre-eminent. The results of an investigation of the use of copper in the electrical industry would not be of great value, but it would be worth while to ascertain why ferrous metals have replaced copper and brass in many structural parts of machines where corrosion is fatal.

The use of copper substitutes has become more prevalent since the beginning of the war than previously. At that time limitations on the use of copper for private purposes were imposed be-

cause all of the copper that was obtainable was needed for munitions. During that interval manufacturers began to employ copper substitutes and the public learned to use them. The use has persisted although the substitutes are in many cases uneconomical, and time has been insufficient to prove their inferiority. To ascertain what the users think about the comparative merits of copper and substitute mechanical equipment is part of the information sought in the survey.

In conducting the survey, those who are unfamiliar with copper as an engineering material will be interrogated, rather than those who are familiar with it. One of the methods of appealing to the ultimate consumer has been to offer a prize for an essay on copper, competitors being restricted to high school students. Another source of information was a questionnaire sent to newspaper editors in small towns. Both expedients provided a mass of material that is valuable as a means of attaining the ends sought by the research committee. The investigation will include all of the United States, England, and the principal countries of Europe. It will be completed early in the autumn.

COMMITTEE APPOINTMENTS MADE BY A. I. E. E.

President Berresford Names Heads of Different Committees at First Meeting of Organization's Administrative Year.

At a meeting of the board of directors of the American Institute of Electrical Engineers, held in New York City, August 12, President A. W. Berresford appointed committees for the administrative year beginning Aug. 1, 1920, as follows:

Finance, Charles Robbins, Pittsburgh; meetings and papers, W. I. Slichter, New York City; publication, N. A. Carle, Newark, N. J.; board of examiners, Clayton H. Sharp, New York City; sections, John B. Fisken, Spokane; student branches, C. Francis Harding, Lafayette, Ind.; membership, E. H. Martindale, Cleveland; public policy, H. W. Buck, New York City; law, Samuel Sheldon, Brooklyn; headquarters, William A. Del Mar, New York City; safety codes, Farley Osgood, Newark, N. J.; code of principles of professional conduct, George F. Sever, Boston; U. S. national committee of the International Electrotechnical Commission, C. O. Mailloux, New York City; standards, D. C. Jackson, Boston; co-ordination of Institute activities, L. T. Robinson, Schenectady; economics of electric service, Philip Torchio, New York City; educational, C. E. Magnuson, Seattle; electrical machinery, B. A. Behrend, Boston; electrochemistry and electrometallurgy, F. A. J. Fitzgerald, Niagara Falls; electrophysics, F. W. Peek, Jr., Pittsfield, Mass.; industrial and domestic power, A. G. Pierce, Pittsburgh; instruments and measurements, F. V. Magalhaes, New York City; iron and steel industry, W. F. James, Philadelphia; lighting and illumination, C. E. Clewell, Philadelphia; marine, Arthur Parker, Camden, N. J.; mines, Graham Bright, Pittsburgh; power stations, H. P. Liversidge, Philadelphia; telegraphy and telephony, Donald McNicol, New York City; traction and transportation, Charles S. Ruffner, New York City; transmission and distribution, E. B. Meyer, Newark, N. J.

In accordance with the by-laws of the Edison medal committee, the board confirmed the appointment by President Berresford of Comfort A. Adams as chairman of the committee, and of H. M. Byllesby, Chicago; D. E. Drake, New York City, and W. L. R. Emmet, Schenectady, as three members of the committee for terms of five years each. The board also elected three of its own membership as members of the Edison medal committee for terms of two years each, as follows: W. I. Slichter, New York City; L. E. Imlay, New York City, and F. D. Newbury, Pittsburgh.

DEVELOPMENT OF CENTRAL STATIONS IN CANADA.

Recent Report Shows Rapid Strides Made in Central-Station Industry—Utilization of Water Power an Outstanding Feature.

Evidence of the extensive development of one of Canada's fundamental industries is given in the second report of the census of central stations in Canada, recently issued by the Dominion Bureau of Statistics. The total capital invested is $401,942,402, of which $356,547,217 represents the investment in power development and transmission systems, and $45,395,185 represents miscellaneous supplies and working capital. The commercial or privately owned stations reported 71.7% of the total capital investment and the municipal or publicly owned stations 28.3%. The total number of persons reported as employed in the industry is 9696, with salaries and wages amounting to $10,354,242.

The aggregate receipts from the sale of electrical energy for all stations amounted to $53,549,133, of which the commercial stations reported $33,190,882, or 62%, and the municipal stations $20,358,251, or 38%. It should be noted that this revenue includes the income received from the resale of energy purchased in bulk by one central station from another central station. The resale of energy by a second station must obviously take care of the purchase price of such power and the distribution charges.

The total capacity of primary power machines was reported as 1,958,642 hp., of which 1,841,114 hp. represents the installation in principal plants, and 117,528 hp. the equipment of auxiliary or stand-by plants. Of the total capacity of primary power equipment in principal plants the commercial stations reported 77.9% and the municipal stations 22.1%. The capacity of the waterwheel and hydraulic turbine installations was given as 1,682,191 hp., or 91.4% of the total capacity of all primary power machines in the principal stations, and was 85% of all the primary power equipment of both principal and auxiliary or stand-by stations. The capacity of the steam reciprocating engines and steam turbines was given as 145,637 hp., or 7.9%, and of the internal-combustion engines 13,286 hp., or 0.7% of the principal station primary power equipment.

According to a recent census, 72.7% of the total water power developed in Canada is employed in connection with the central-station industry. Quebec, Ontario, Manitoba, British Co-

lumbia and the Yukon Territory each derive over 95% of their total electric power from water. The capital invested in the hydroelectric stations and the non-generating stations which purchase their power from these hydroelectric stations is $364,477,961, or 90.7% of the total investment of all central stations in Canada. Practically every large industrial center is now served with hydroelectric power and has ample reserves of water power within easy transmission distance.

BROOKLYN UTILITY ISSUES NOTICE OF SERVICE DISCONTINUANCE.

It is reported that the Kings County Lighting Co., Brooklyn, N. Y., has issued a notice to its 250,000 consumers that the company is confronted with financial disaster and will be unable to continue operations through the winter. Through failure of the Public Service Commission to allow increased rates, the company, it is set forth, is not only unable to make improvements costing $2,500,000, as ordered by the commission, but it cannot defray running expenses. Ralph Elsman is vice-president, making the statement.

PRODUCTION OF ANTHRACITE COAL AHEAD OF 1919.

At the present time the production of anthracite coal in this country is 3,141,000 tons ahead of the production at the same time in 1919. Cars of anthracite loaded by the principal carriers during the week ended Aug. 7 numbered 34,214. This indicates a total output, including mine fuel and sales to local trade, of 1,757,000 net tons. This was a decrease of 103,000 tons below that of the preceding week and of 113,000 tons, or 6%, when compared with the corresponding week of 1919. The low rate of anthracite production is attributable to the local strike at Pittston, Pa. Cumulative production since the beginning of the calendar year now amounts to 52,318,000 net tons as against 49,177,000 tons in 1919.

The importance of anthracite production to the users of steaming coal lies in the fact that an increased production of hard coal relieves by that amount the demand for soft coal for domestic service. An increase of 3,000,000 tons of anthracite at the present time should mean a total increase for the year of 5,000,000 tons. Such an amount of coal is sufficient to supply from 12.5 to 15% of the entire coal requirements of all the electric-utility companies in the country.

N. E. L. A. TO APPOINT COMMITTEES ON PUBLIC RELATIONS.

As this issue goes to press the executive committee of the Public Relations Section of the National Electric Light Association is holding a meeting on board a yacht somewhere on Lake Erie, the purpose of which is to appoint committees dealing with all phases of public relations. It is also understood that the full program of the section will be outlined and discussed, particular attention being given to the publicity program already tentatively arranged, and which will begin immediately following the meeting. It is anticipated that, with two exceptions, every member of the executive committee, including one representative from the Public Relations Section of each of the 13 geographic divisions, will attend the gathering. F. R. Coates, of Toledo, O., a member of the executive committee, was instrumental in securing the yacht for this special meeting.

SERVICE VERSUS METER CHARGE FOR ELECTRICAL ENERGY.

The Massachusetts Department of Public Utilities recently heard representatives from central-station and gas companies and municipal lighting departments, who appeared in support of a service charge and urged the repeal of the existing law prohibiting the imposition of a meter charge where the consumption of energy exceeds $9 annually. It was pointed out by E. C. Mason, of Boston, that 38 states at present allow a service charge, and the suggestion was made that only by its use can equitable rates be applied among different groups of customers. In the case of the Greenfield Electric Light & Power Co. it was stated that over 1000 customers consume less than 8 kw-hrs. per month, or less than $1 worth of energy, and that 22% of the customers use only 4% of the energy sold. The matter was taken under advisement by the department.

COMING CONVENTIONS.

Michigan Section of the National Electric Light Association. Annual convention, Ottawa Beach, Mich., Aug. 24-26. Headquarters, Hotel Ottawa. Secretary, Herbert Silvester, Ann Arbor, Mich.

Nebraska Section of the National Electric Light Association. Annual convention, Omaha, Neb., Sept. 8-9. Secretary, B. H. Conlee, Nebraska Gas & Electric Co., Beatrice, Neb.

Pennsylvania Electric Association. Annual convention, Bedford Springs, Pa., Sept. 8-11. Secretary, H. M. Stine, 211 Locust street, Harrisburg, Pa.

Northwestern Geographic Division of the National Electric Light Association. Annual convention, Spokane, Wash., Sept. 8-11. Secretary, L. A. Lewis, Washington Water Power Co., Spokane, Wash.

Association of Edison Illuminating Companies. Annual convention, Eastern Point, New London, Conn. Sept. 13-16. Headquarters, Griswold Hotel. Secretary, Preston S. Millar, 80th street and East End avenue, New York City.

New England Section of the National Electric Light Association. Annual convention, Kineo, Me., Sept. 13-16. Secretary, O. M. Bursiel, 149 Tremont street, Boston, Mass.

Illuminating Engineering Society. Annual convention, Cleveland, Oct. 4-7. General Secretary, Clarence L. Law, 29 West 39th street, New York City.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 4-8. Headquarters, Southern Hotel. Secretary W. H. Morton, 110 West 40th street, New York City.

Empire State Gas & Electric Association. Annual convention, Utica, N. Y., Oct. 7-8. Headquarters, Hotel Utica. Secretary, Charles H. B. Chapin, 29 West 39th street, New York City.

National Association of Electrical Inspectors. Annual meeting, Philadelphia, Oct. 12-13. Secretary, W. L. Smith, Concord, Mass.

International Association of Municipal Electricians. Annual convention, New Orleans, La., Oct. 19-22. Secretary, Clarence R. George, Houston, Tex.

Electric Power Club. Fall meeting, Hot Springs, Va., Nov. 15-18. Headquarters, Homestead Hotel. Secretary, C. H. Roth, Adams and Loomis streets, Chicago.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

RATE INCREASES REPORTED BY PUBLIC UTILITY COMPANY.

The American Light & Traction Co. reports the granting of substantial rate increases to several subsidiaries, including increases at Binghamton, N. Y.; Grand Rapids and Muskegon, Mich.; increases in street-railway fares at Muskegon; and abolition of all increment rates at St. Paul, Minn. Application for increases in rates have also been filed by the company at Detroit, St. Paul, Long Branch, N. J.; St. Joseph, Mo., and San Antonio, Tex.

UTILITY RATES ADJUSTED BY DIFFERENT STATES.

Missouri Commissioner Says Service to Public Was Jeopardized When Rising Costs Absorbed Income.

Have utility rates been adjusted by the different state commissions to meet the extraordinary production costs and insure service to the public? They have, and had they not been the companies would have been unable to purchase supplies or pay labor, and the country would soon have been in a critical position for want of electric light and power, gas, transportation and telephone service, says Judge David E. Blair, of the Missouri State Public Service Commission. He points out that labor, fuel and materials used by the public service companies have advanced 75 to 300%, and that the belated adjustments asked by the companies have been moderate.

"The country faced a nation-wide crisis with respect to its utilities," said Judge Blair. "During the first four years of its existence the Missouri commission had smooth and pleasant sailing. In very many cases rates were readjusted, numerous rates being lowered, and except for railroad rates, practically none were raised.

"Then one unfortunate day the nations of the world were plunged into war. Millions of men were withdrawn from production and set to work at destruction. Those utilities whose rates were just sufficient to earn them their operating expenses, and not more than a very modest return on their investment, were the first to feel the pinch.

"To their credit be it said that they did not immediately come to the commission for relief. But it soon became apparent that the attendant high prices were to drag on for years, and the burden of operating losses would soon wreck practically every utility unless substantial relief was obtained.

"While men complaisantly pay two or three times the old prices for food and clothing, building materials and amusements, an advance from 20 to 40% in utility service sometimes is met by disapproval. The general public does not seem to get the idea that if labor, fuel and materials advance 75 to 300%, their utilities will have difficulty in rendering the service at the same old price."

RULES FOR RURAL LINE EXTENSIONS MEET APPROVAL.

Importance of Regulations as Outlined in Draft Presented by Wisconsin Utilities Is Commented on by State Commission.

The Wisconsin Railroad Commission has approved the proposed rules for electric rural extensions as formulated by a committee of the Wisconsin Electrical Association and adopted at the last annual meeting of the association. Application for approval of the rules was made to the commission by the Wisconsin Power, Light & Heat Co., the Central Wisconsin Utilities Co., the Wisconsin Valley Utilities Co. and the Mineral Point Public Service Co.

In approving the proposed rules the commission said:

"For the past year or more, there has been an increasing demand for rural electric service. On account of the comparatively large investment per consumer and the resulting high maintenance, depreciation and taxes, as well as the comparatively large transformer and line losses, and the inconvenience of inspection, repairs and meter readings, many utilities have been reluctant to engage in rural business. Some companies, which have taken on rural consumers, have found that the business resulted in a considerable loss, and have appealed to the commission for relief in the form of a rate increase.

"When contracts, either written or verbal, have been entered into between a utility and its rural consumers and when all or part of the construction cost of the extension required to serve such consumers has been advanced by the consumers the necessity for a rate increase should be very urgent before the commission would be justified in authorizing any rate higher than that specified in the contract.

"It is therefore important that a utility develop its rural business on such a basis that it will be self-supporting within a reasonable length of time and will impose no undue burden on the urban consumer.

"The nature of rural business is such that the fixed charges, losses and operating expenses are much greater than the same items for an equivalent income from urban business. It is quite possible that the cost of rural service might, with the adoption of high standards of construction, in many cases become prohibitive. On the other hand the connection of inadequate or unsafe construction to the transmission or distribution systems of a utility will introduce a hazard to the

entire service. It therefore appears that the adoption of minimum standards required by the commission's rules for the safe construction and operation of electric systems will safeguard the service of the utility and at the same time involve no unnecessary expenses for rural consumers.

"It has been contended that utilities should finance and construct all rural extensions and charge a rate commensurate with the cost of service. This plan has many advantages as it eliminates all questions raised because of the consumer being required to pay the cost of construction on public highways which, to comply with the law, shall be the property of the utility. It eliminates many questions as to the basis on which additional consumers should be connected, or the lines extended or reinforced, and the necessity of segregating the property paid for by consumers in valuations for rate making, securities issued or sale. Practical consideration at the present time makes this method of financing impractical for most utilities.

"To encourage the development of rural electric service, eliminate the present reluctance of many utilities to engage in this class of business, and enable rural districts to secure service, the business must not only be permitted to earn the same rate of return that is considered reasonable in the urban portion of the utility's business, but the utility must be permitted to make terms as to financing which will make possible the immediate investment of considerable sums of money in rural extensions without taxing the resources of the utility for securing capital.

"It is quite likely that under present conditions a utility would be forced to pay a higher rate of interest to secure funds for financing an entire program of rural extensions than the average rural consumer would be required to pay to finance the comparatively small amount represented by his individual share. As this interest rate would be reflected in the rate paid for service it is to the advantage of all concerned that the required funds be secured at as low a rate as possible.

"Some utilities have attempted to overcome the difficulty of financing rural extensions by a plan whereby the consumer is required to advance the cost of the line and receive a refund of all or part of the monthly bills for service until the amount of advance has been refunded. This plan has the advantage of eliminating to some extent the question of financing and permanence of the business.

"It does not possess the advantages which result from a high initial charge and comparatively low rates as the rates under this plan would be but slightly less than they would be in the case the company financed the extension. As the utility should be allowed only an adequate return on the investment including a proper allowance for depreciation, this refund plan would either keep the utility from part of its legitimate return or it would be necessary from time to time to market securities to take care of the purchase of the line from the consumer on a partial payment plan.

"In many cases, particularly where rural lines are served by municipally owned utilities, the utilities have been unwilling to accept the obligations incident to the ownership of the rural lines even though such lines be turned over to them at no initial cost. In several such cases it has been necessary for the group of rural consumers to organize a corporation, purchase energy at a wholesale rate, and engage in the utility business to comply with the law. Such organizations are ordinarily formed with no idea of profit, but merely as the only means of securing service. This plan is not to be recommended for many reasons.

"It forces the rural consumer into a business about which he knows little and burdens him with the expense of forming and maintaining an organization and the compilation of numerous comparatively unimportant, but legally necessary, reports. It places the responsibility for maintenance of lines and equipment in inexperienced hands with the consequent liability of accident to workmen and public. The limited liability of the small corporation is such that its resources would in many cases be severely taxed to settle even a nominal accident claim and in many cases a claim of any importance could not be satisfied by the market value of the physical assets of the corporation.

"There is little likelihood of such an organization being able to secure service at any appreciably lower rate than that provided by the proposed rules if proper maintenance is provided and proper accounting systems adopted. In some cases which have recently come to our attention the rates worked out at the beginning of the enterprise, but are already proving inadequate notwithstanding the fact that no depreciation is being provided.

"The proposed rules provide no method of apportionment of the construction cost of the line among the various consumers. This is frequently one of the most difficult points to settle in connection with the promotion of a rural extension. While in the final analysis strict justice probably demands that no consumer should be required to pay more as a member of a group than he would be required to pay if he were to be served under the rules as an individual, it is our opinion that a rural extension should, as is apparently the intent of these rules, be considered as far as practical as a community enterprise in which all will benefit equally.

"It has been suggested that one or more individuals may feel financially unable to meet his share of the construction cost at once and that a partial payment plan be developed to handle such cases. While the existence of such an alternative might tend to hamper the financing of some extensions, it is greatly to the advantage of both consumer and utility that the rural line reach its ultimate development as early as possible. Such a plan might be of advantage in obtaining this end.

"The subject of electric rural extension is so involved that a rule to adequately cover all points which may arise is practically out of the question and it is to be expected that much development may be anticipated along these lines, but the proposed rules appear to cover the more important points, and the application of such rules will undoubtedly furnish much data for the further study of the problem."

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

FACTORIES TAKING TO OUTDOOR SUBSTATIONS.

Cheap Land and Valuable Floor Space Make Outdoor Installations Desirable to Industrial Plants.

Outdoor substations have long been used for high-voltage installations where considerable space would be required to maintain the necessary clearances between conductors and so cause high housing costs, and where the installations are small and it became necessary to keep the cost down to the minimum. Both these reasons for the outdoor substation are well known. The outdoor substation is now finding use to an increasing extent for another reason aside from that of initial cost, namely, the value of floor space. Indoor space occupied by electrical apparatus is space that might be utilized for production or storage. Installing the electrical apparatus outdoors saves space, and at the same time permits all the advantages of the outdoor installation to obtain.

The accompanying illustration shows an outdoor substation at the plant of the Libby, McNeill & Libby Co., Blue Island, Ill. This company's preserving factory is one of the largest in the world, having hundreds of acres of floor space.

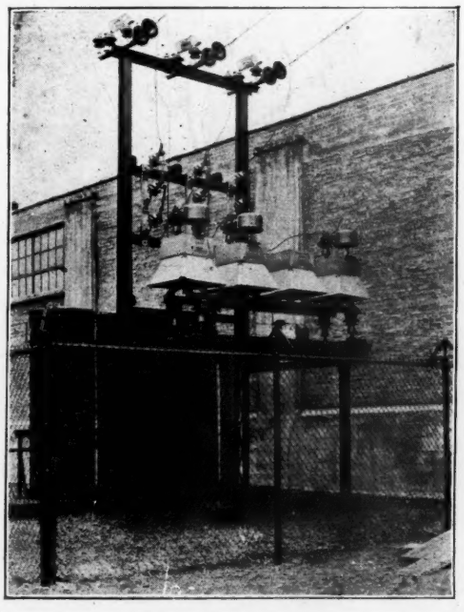


Fig. 1.—Outdoor Substation Employed by Factory Where Floor Space Is Valuable for Production.

The outdoor substation is tucked away in a space between buildings where it is not in the way, but where it is close to the center of gravity of the load.

With this arrangement there is no fire risk, no difficulties with the incoming 20,000-volt lines, and the installation is of the simplest type. The voltage is stepped down from 20,000 to 2200 volts, and is again transformed to 220 and 110 volts for general distribution. One of the distributing transformer banks, where pressure is

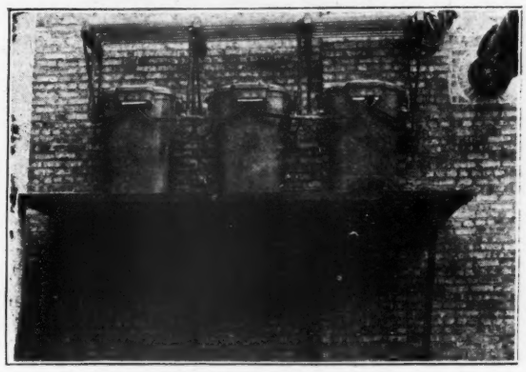


Fig. 2.—Method of Mounting Small Transformer Bank on Wall of Factory Building.

changed from 2200 to 220 volts, is shown in Fig. 2. Taps are taken off the secondary leads so that the transformer may deliver both 220 and 110-volt three-phase service. It should be noted that even this bank of transformers is located outside the building.

VENT PIPE FACILITATES OPERATION OF SUBWAY CUTOUTS.

Air Bell Provides Cushioning Effect and Prevents Damage When the Fuse Is Blown With Water in the Manhole.

A series of oil fuse cutouts of the subway type are shown installed in a manhole in the accompanying illustration. It will be noted that an iron pipe connects all the cutouts together, and extends down to near the floor of the hole. This pipe serves to ventilate the various fuse chambers, and is open at the bottom to permit the escape of the gases resulting from the blowing of a fuse.

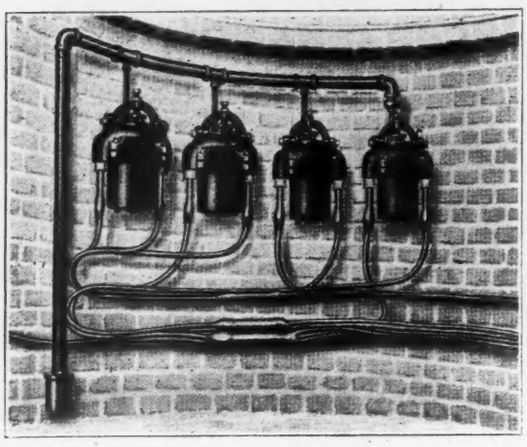
In these cutouts the fusible element is placed under a heavy body of special oil. On the blowing of the fuse the terminals are forcibly thrown apart, and the oil aids in preventing a continuation of the arc. The ventilating system, including the pipes already mentioned, prevent the accumulation of pressure within the cutout body.

TABLE SHOWING AIR-BELL SIZES FOR VARIOUS SIZES OF SUBWAY-CUTOUT VENTS.

Voltage rating.	Amperes capacity.	Volume of air bell.
2500	50	1 pint
2500	100	2 pints
2500	200	4 pints
4100	150	4 pints

Special arrangement of this system also prevents the blowing out of any considerable quantity of the oil bath.

Gas formed by the blowing of the fuse link



Subway Cutouts Connected to Vent Pipe.

travels upward, carrying with it, in the form of froth, a certain amount of oil. This froth strikes a series of screen baffle plates and is broken up into gas and oil drops, the gas passing around a series of baffles and out through the vent pipes to free air. The oil collects and returns by gravity to the body of the cutout.

For the cutouts rated at 2500 and 4400 volts the manufacturer recommends that vent pipes be not smaller than 1 in. in diameter, with larger pipes in proportion when more than one cutout is connected to the same vent. In installing vent pipes care should be taken to have all joints tight; loose joints will allow water to back up into the vent and interfere with operation when the manhole is flooded with water.

The accompanying table shows the proper size of air bell to connect to the bottom of the vent for various sizes of cutouts. Where more than one cutout is served by a single vent the bell should be large enough to provide capacity for all units connected.

TWO-WATTMETER METHOD OF TESTING THREE-PHASE MOTOR.

Total Input and Power-Factor Is Determined by Two Wattmeters, Two Ammeters and Two Voltmeters.

For making accurate tests of input and power-factor on three-phase motors, connections are made as shown in the accompanying illustration. With this arrangement the voltmeters give the voltages across two of the phases, the ammeters give the currents in two of the lines, and the total power in the circuit is equal to the sum of the two wattmeter readings.

This method gives correct results even though the voltages are considerably unbalanced. With light load one of the wattmeters will probably have a negative reading, and it will be necessary to reverse either its current or potential leads in order to read the deflection. In this case the reading obtained from the reversed wattmeter should be subtracted from that obtained from the other meter. In other words, the algebraic sum of the two readings must be taken. For example, if one meter reads 550 watts and the second meter reads 150 watts, after the connections have been reversed, the total input will be 400 watts.

As the load on the motor is increased, the negative reading will become smaller and will finally become zero and then reverse. At this point in the test the meter connection can be restored to normal, and the readings of the two meters must be added instead of subtracted to secure the true input to the motor. The negative reading of one meter is caused by the lowering of the power-factor to below 50%, power-factors of this order being obtained on many induction motors at light load. It is a fairly simple matter to demonstrate by mathematics why one meter reads negative at low power-factor, but such demonstration is not essential to the use of the equipment in making the test. When both meters read correctly, when connected as shown in the illustration, the power-factor is above 50%.

Instantaneous values of power-factor may be determined by computations made from the simultaneous readings of all six meters. The formula, $P = W/EI\sqrt{3}$, may be used to determine the numerical value of the power-factor. In this equation P is the power-factor, W is the sum of the two wattmeter readings in watts, E is the average of the readings of the two voltmeters, and I is the average of the two ammeter readings.

It should be remembered in making this test and in interpreting the results that the two wattmeters read the entire input into all three phases, and not the input into any one phase. Readings of one of the meters, when considered alone, have no meaning whatever.

Readings taken with this kind of a connection may be used to determine the motor efficiency when the mechanical output of the motor is

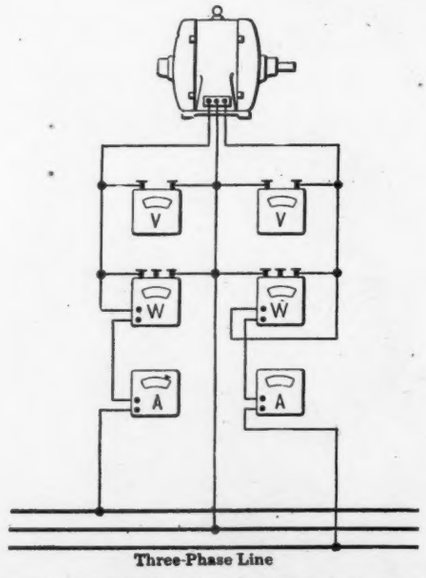


Diagram of Connections for Testing Three-Phase Motor by the Two-Wattmeter Method.

measured at the same time with a brake or dynamometer. In testing a motor or generator of any kind, it is always well to use one or more thermometers to determine the rise in temperature of the windings. Motor speeds should also

be taken when making a thorough test, care being taken to maintain the load at a definite value while speed measurements are made.

ENERGY PRODUCED AND FUEL USED IN PUBLIC UTILITY PLANTS.

Statistics by United States Geological Survey Show Where Power Is Produced by Utilities and Amount of Fuel Used.

The accompanying tables show in detail the monthly use of fuels and the production of electric power in the plants of public utility companies, power production being segregated by states. Analysis of these tables may be made to show much interesting information regarding the use of power in various parts of the country, relative importance of various types of fuel in the public service field, etc.

Comparing the figures here presented with similar figures prepared for the same period of last year shows an increase of 16.7% in the mean daily output. From this it seems evident that the central-station business has been going ahead steadily in spite of the many obstacles encountered during recent months. Examination of other portions of the tables shows the increase in volume of energy produced by water power as the seasons advance. The increase of output in May over that in January and February amounts to approximately 27%.

Data for the past year shows a total power production for 1919 of 38,900,000,000 kw-hrs., and a fuel consumption of 35,000,000 tons of coal, 11,500,000 bbls. of oil and 21,700,000,000 cu. ft. of gas. Of the total energy produced, 14,740,000,000 kw-hrs. was produced from water power. A great variety of information and general conclusions may be drawn from the tables by giving them consideration from the proper point of view.

ELECTRIC POWER CLUB FIXES DATE OF FALL MEETING.

The fall meeting of the Electric Power Club will be held Nov. 15-18 at Hot Springs, Va., with headquarters at the Homestead Hotel. The program for the meeting is now being prepared and will be announced later.

TABLE SHOWING THE PRODUCTION OF ELECTRIC POWER FOR THE FIRST FIVE MONTHS OF 1920 BY PUBLIC UTILITY PLANTS IN THE UNITED STATES.

State.	Thousands of Kw-hrs. Produced by Water Power.					Thousands of Kw-hrs. Produced by All Types of Fuels.				
	January.	February.	March.	April.	May.	January.	February.	March.	April.	May.
Alabama	34,864	36,780	39,354	37,669	40,941	14,435	7,916	9,724	10,616	8,501
Arizona	8,567	6,883	8,899	10,278	10,512	4,008	3,622	4,383	3,836	4,934
Arkansas	132	120	130	99	107	9,290	8,326	9,048	8,242	8,378
California*	166,243	148,836	203,060	219,475	225,720	113,127	112,116	80,309	66,003	72,954
Colorado	12,784	12,082	12,650	13,527	15,367	22,851	19,317	20,416	17,859	16,115
Connecticut	9,069	8,553	17,716	19,433	19,151	57,874	48,410	46,097	35,680	37,636
Delaware	0	0	0	0	0	6,807	6,138	6,263	5,994	6,046
District of Columbia	0	0	0	0	0	23,317	20,763	21,356	20,017	20,254
Florida*	965	818	1,024	861	934	10,597	10,461	10,868	10,024	9,535
Georgia	43,816	42,016	43,597	39,963	39,402	10,696	8,260	8,770	8,736	8,442
Idaho*	48,564	43,336	43,072	47,253	56,387	338	123	305	127	125
Illinois	14,831	14,147	14,588	13,874	15,202	260,651	239,858	246,663	236,040	227,219
Indiana	2,943	2,741	3,637	3,982	3,471	91,848	71,449	73,351	70,166	68,899
Iowa	55,538	49,415	54,417	51,594	59,291	31,647	30,271	29,831	27,624	26,416
Kansas	1,741	1,240	1,598	2,054	2,597	35,913	32,403	32,899	29,016	30,250
Kentucky	0	0	0	0	0	23,455	21,775	22,711	21,812	21,813
Louisiana*	0	0	0	0	0	18,126	16,755	17,859	16,607	17,993
Maine	29,310	25,037	29,444	28,382	29,356	1,577	1,614	918	747	391
Maryland	284	327	131	265	169	31,261	26,889	21,530	17,199	15,294
Massachusetts	21,987	16,248	34,844	44,265	42,670	151,088	129,709	121,578	108,844	100,782
Michigan	50,293	46,270	63,402	70,846	59,965	138,152	128,551	129,252	96,788	112,361
Minnesota*	27,954	26,572	32,750	40,374	38,671	36,157	29,914	23,268	9,714	8,228
Mississippi*	0	0	0	0	0	5,848	4,783	5,652	5,041	5,598
Missouri	5,720	3,987	4,916	6,949	5,382	54,118	52,705	53,964	51,718	49,237
Montana	89,574	90,411	104,991	100,008	94,952	596	540	515	482	502
Nebraska	909	662	668	582	807	20,446	17,313	18,025	19,011	19,260
Nevada	3,416	3,420	3,180	2,803	2,646	852	845	882	805	803
New Hampshire	4,322	4,001	5,835	5,823	5,667	5,166	4,289	2,319	2,155	2,130
New Jersey	143	102	155	164	181	101,558	88,120	94,979	86,964	85,584
New Mexico	53	57	59	73	82	1,360	1,272	1,349	1,399	1,467
New York	227,033	203,184	248,207	269,491	250,147	382,194	338,935	328,475	292,229	289,947
North Carolina	52,880	48,576	59,239	57,761	59,763	10,745	9,040	9,655	9,223	8,998
North Dakota	0	0	0	0	0	2,718	2,279	2,170	1,968	1,894
Ohio	1,490	2,101	3,222	2,827	3,200	258,426	235,533	252,793	238,355	231,100
Oklahoma	217	182	185	51	143	16,946	15,313	16,022	15,349	16,289
Oregon*	32,383	28,347	32,388	31,529	32,078	7,845	8,624	7,788	5,470	6,944
Pennsylvania	45,359	45,500	56,903	55,866	61,946	332,973	296,661	324,866	302,224	284,545
Rhode Island	355	436	719	628	933	37,114	32,539	26,876	23,641	20,024
South Carolina	59,698	52,137	55,030	54,194	54,140	5,768	4,563	4,976	4,320	4,637
South Dakota	477	474	1,162	1,487	1,412	3,382	3,258	2,789	2,136	2,375
Tennessee	39,443	31,664	36,596	37,292	41,092	9,834	11,500	9,730	11,515	10,771
Texas	74	231	380	299	292	55,463	49,719	53,409	51,004	46,784
Utah	13,932	14,559	18,565	14,656	13,892	0	8	12	30	6
Vermont	15,467	11,732	18,969	17,806	21,992	786	1,038	344	137	86
Virginia	13,809	16,460	21,320	20,257	16,984	30,435	24,245	22,219	21,530	22,671
Washington*	103,631	94,597	98,507	95,672	94,817	4,960	3,394	3,287	2,697	2,362
West Virginia	1,776	2,334	2,101	2,319	2,391	96,740	83,958	94,999	88,886	91,571
Wisconsin*	36,139	30,873	43,006	56,660	58,221	42,331	43,601	43,884	36,501	36,440
Wyoming	152	145	171	169	172	4,585	4,178	4,162	3,922	3,730
Total	1,278,337	1,162,593	1,420,781	1,479,560	1,483,245	2,586,699	2,312,944	2,323,540	2,100,383	2,069,721
Total by water power and fuels						3,865,036	3,475,537	3,744,321	3,579,943	3,552,966

*The kilowatt-hours of energy produced by plants utilizing wood for fuel are as follows: California, 577,000; Florida, 566,000; Idaho, 50,000; Louisiana, 289,000; Minnesota, 643,000; Mississippi, 578,000; Oregon, 6,390,000; Washington, 857,000, and Wisconsin, 463,000.

TABLE SHOWING AMOUNTS OF FUEL USED TO PRODUCE ELECTRIC POWER IN PUBLIC UTILITY PLANTS IN THE UNITED STATES FOR THE FIRST FIVE MONTHS OF 1920.

	January.	February.	March.	April.	May.
Coal, short tons	3,619,069	3,275,641	3,265,039	2,932,093	2,840,771
Petroleum and derivatives, bbls.	1,257,711	1,143,354	1,058,511	910,757	921,973
Natural gas, thousands of cu. ft.	1,372,109	1,258,893	1,536,681	1,777,226	1,969,205

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

Automatic Electric Range With Service Features.

Some of the features of the type M-1 electric range, placed upon the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., are instantly removable burners, heavy bus-bar connections, removable plat-

Type M-1 Westinghouse Automatic Electric Range.

form allowing easy access to connections, separate fuse boxes, interchangeable oven and platform allowing a change to right or left hand in 15-min. time and automatic control through door hinges enabling the replacing of oven doors without touching the wiring. Defective parts may be easily and quickly replaced at a minimum cost in time and labor.

The range is controlled by three-heat, double-pole indicating switches, each switch being marked for the particular burner it controls. The fuses, circuit-breaker and switches are located in a box under the cooking top where they are easily accessible. All switches have a rotating dial with white markings located on the cover plate.

Each range is furnished with a thermometer fitted in the door which enables the user to tell at a glance the degree of heat in the oven. The wiring for this thermometer is carried through the hinges on the door and there is no wiring to replace if a new door be installed. A lamp socket located under the range shelf can be used to illuminate the burners or as an attachment for small appliances.

The oven is lined with aluminum-composition-coated sheet metal and there are white porcelain splashers at the sides and back of the shelf. The oven is fully equipped with aluminum broiler pans which have wire racks for roasting, baking, drying or preserving fruits, vegetables, etc. A burner of 2000-watt capacity is the only equipment for the oven and broiler. There are four 8-in. burners on the stove top, two being of 1500-watt rating and two of 1000-watt rating. All burners are of the open-coil type. All types of the M-1 ranges are made throughout of sheet metal, which, finished in black japan, makes a neat, attractive appearance, as well as being rust resisting.

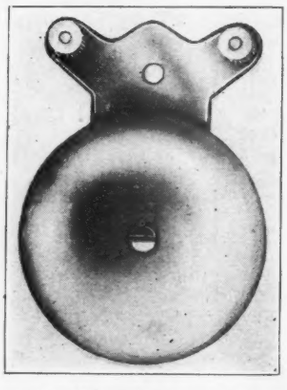
Ranges are furnished with either full-automatic, half-automatic or non-automatic equipment. Full-automatic ranges are equipped with a clock to turn the burners on and a thermostat to turn them off while the half-automatic range has only a thermostat.

Phasing Auto-Transformer.

A special phasing transformer intended for use in testing and measuring power-factor has been placed on the market by the States Co., Hartford, Conn. Features of design make this equipment particularly suitable for power-factor measurements.

Electric Bell with Housed Parts.

Simplified construction marks the electric bell about to be placed upon the market by Marcelle T. Harding, 209 East 19th street, New York City. The movement of the bell is housed beneath the gong, which can be removed by unscrewing at the top. The bell can be quickly converted into a buzzer.

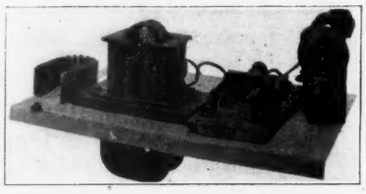


Harding Electric Bell.

All parts are made with punches and dies. The electromagnet is of horse-shoe form, the ends projecting downward toward the base and supporting the contact-bracket and armature. The bell will operate on a transformer or with one or more dry-cell batteries, ringing in any position.

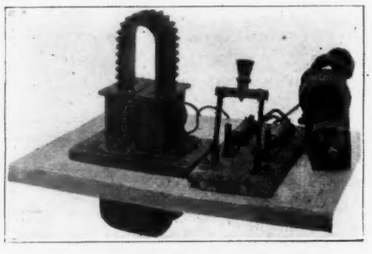
Outfit for Charging Magnets.

Magnetos, relays and other devices employing permanent magnets in their construction are in time rendered inefficient because of the weakening of the magnets. It often happens that such weakened magnets are recharged by making contact with the field poles of generators or other sources of strong magnetic fields. This practice is unreliable and uncertain as to results, and may result in damage to the machine or injury to the person recharging the magnet if the machine is not shut down. To provide for this kind of service. The Esterline Co., Indianapolis, Ind., has developed and placed on the market a special charging device.



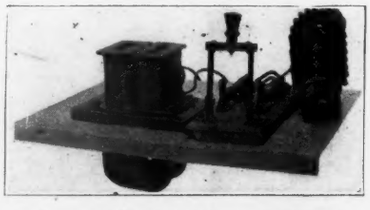
Magnet Being Charged in Solenoids.

This device has been designed with the idea of securing the maximum charging of the magnets, and also of getting them into place without losing a large portion of the initial charge. The charging device consists of a pair of solenoids, a U-shaped keeper, a flex-



Magnet Being Removed With Keeper.

ible keeper and the required switches and connections. In charging a magnet it is placed in the solenoids in contact with the U-shaped keeper and the current is switched on for a short interval. With the keeper and magnet in contact both are raised until the magnet is en-



Magnet Replaced After Charging.

tirely out of the solenoids, after which the flexible keeper is laid over the magnet and removed with it. The magnet and keeper are left together until the magnet is in place, when the keeper is removed, leaving the magnet with a substantial charge. Experience shows that this method of charging and applying magnets gives much greater strength than the methods ordinarily used, according to the statement of the manufacturer. The coils are wound on bronze spools, and can be furnished for any commercial d-c. voltage.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Green Engineering Co., East Chicago, Ind., is erecting an extension to its machine shop, 51 by 323 ft., to cost $25,000.

Wayne Electric Manufacturing Co. has leased the building at 157 West 54th street, New York City, for a new local establishment.

Wells Manufacturing Co., Fond du Lac, Wis., is erecting a two-story, 46 by 50-ft. brick addition to its plant. Equipment will be installed for the manufacture of electrical devices.

Standard Electric Manufacturing Co., 216 North Clinton street, Chicago, is erecting a new plant on Wrightwood avenue, to be used for the manufacture of electric switches, etc. The plant will be five stories, 80 by 150 ft., and the cost is estimated at approximately $250,000.

Whitelite Electric Co., 368 Broome street, New York City, is placing on the market the "Whiter Whitelite," a bowl-enameled lamp. The material used in the enamel, it is stated in the announcement, is carefully compounded and will not chip off or discolor when the lamp is used with the tip down. It may be safely washed in warm water to free it from dust. The lamp is made in the usual "Whitelite" sizes and in all voltages.

Milner-Flower Electric Co., Buffalo, N. Y., has moved from its old location to Main street and is now occupying the entire building at 9 U terrace. The present location has been remodeled especially to accommodate the company's electrical appliance jobbing business, a feature of the building being a display room in the style of a modern residence in which the various household devices are shown in their logical environments.

Steel City Electric Co., manufacturer of electrical equipment, 1207 Columbus avenue, Pittsburgh, is increasing its large modern plant by the addition of a two-story unit, 48 by 55 ft., which will soon be completed.

Pittsburgh Electric & Manufacturing Co., Pittsburgh, Pa., will erect an addition on a recently acquired property, 89 by 440 ft., on Lexington avenue, near Meade street, for the manufacture of electrical products.

Gardner Governor Co., Quincy, Ill., is sending the trade catalogs describing the Gardner horizontal air compressors, Gardner-Rix air compressor and the Gardner duplex pumps, manufactured by the company. The catalogs are fully illustrated and contain valuable tables of data for engineers and power-plant employes.

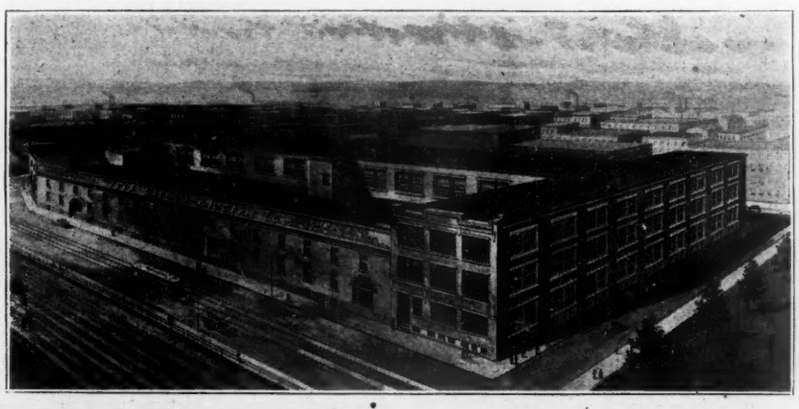
Frank H. Stewart Electric Co., 37 North 7th street, Philadelphia, is sending to the trade its catalog No. 22, just issued, and containing a complete list of "Old Mint" electrical supplies. The catalog has 667 pages of descriptive matter well illustrated. It is entirely new, the work of compilation having been started three years ago with the idea of departing from the old stereotyped form of earlier editions. In its pages are found hundreds of entirely new listings, with descriptions and details of construction as brief as intelligent compilation will permit. The illustrations are all new, the pages extra large, the type clear and descriptions in every case lucid.

Cutler-Hammer Manufacturing Co., Milwaukee, Wis., has issued a new 24-page, 8.5 by 11 ins. booklet entitled "Battery Charging Equipment," and known as publication 830. It describes and illustrates "C-H" equipment for charging all manner of electric vehicles, including passenger cars, large and small industrial trucks, mine battery locomotives, ignition and starting batteries on gasoline cars, etc. The introduction briefly reviews the different methods of charging and kinds of equipment used, with a view to aiding the reader in selecting the type of equipment best suited to the particular conditions of charging. The main part of the booklet takes up the "C-H" charging equipment more specifically, and illustrates and describes the standard unit type and individual type of charging panels for both constant-current charging and automatic fixed-resistance charging. The four last pages of the booklet are devoted to illustrations of special charging equipment.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has awarded a contract for the construction of a one-story, 120 by 200 ft. addition to its plant at Essington, near Pittsburgh. The new addition will be used as a foundry.

Black & Decker Manufacturing Co., Baltimore, Md., manufacturer of portable electric tools, etc., has sent a notice to jobbers stating that no reduction in prices will be made this year. The company also states it will protect jobbers against loss through price reductions for 60 days after the purchase of goods, subsequent to Jan. 1, 1921.

Holophane Glass Co., Inc., 340 Madison avenue, New York City, has published a new illumination handbook entitled "Holophane Datalog." The book has 128 pages and is amply illustrated. It has been compiled from the large volume of lighting data that has been gathered by the engineering department of the company during its 25 years of active illumination work. As the name "Datalog" implies it is a combined data book and catalog. The first 68 pages give detailed information on such engineering subjects as absorption, accident prevention, average flux method of calculation, balancer set, burning position of lamps, candlepower, cleaning, cost of scientific illumination, coefficients of reflection, coefficients of utilization, cosine law, depreciation factor, distribution curve, efficiency of a reflector, effect of dust and dirt, foot candle, formulae for illumination calculations, fundamental principles of illumination, glare, illumination measurements, industrial lighting, inverse square law, maintenance, protective lighting, room ratio, yard lighting, etc. The remaining 60 pages show cuts of photometric curves, dimensions, recommended lamp sizes, spacing and mounting height recommendations and details of installation for various types of lighting units. These types of lighting units include the entire lighting field and are grouped under the following sections: general lighting, industrial lighting, commercial lighting, miscellaneous, street lighting, house lighting, decorative lighting, gas lighting, railroad lighting and fittings. There are also included 46 reproductions of night photographs showing actual installations and giving such details as mounting height, spacing, lamp size, reflector type and foot-candles. The limited number of these books available for distribution to those particularly interested in scientific illumination may be had by addressing the company.



Plant of the Steel City Electric Co. as It Will Appear When New Addition Is Completed.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

A. N. KEMP, vice-president of the Southern California Edison Co., is making an extended trip through the eastern states.

C. M. SEARS, JR., Lennox, Mass., has taken a position as assistant director of the executive managers' course at the General Electric Co., Schenectady, N. Y.

PAUL STARK, auditor of the Eastern Wisconsin Electric Co., Sheboygan, Wis., has been appointed general auditor of the company, with headquarters at Eau Claire, Wis.

N. I. GARRISON, manager of the Oklahoma Gas & Electric Co. at El Reno, Okla., has been elected chairman of the Canadian county chapter of the American Red Cross.

C. V. PEELING, formerly manager of the Cornwall (Ont.) Street Railway, Light & Power Co., has become connected with the Palmetto Power & Light Co., Florence, S. C.

GEN. GEORGE H. HARRIES, vice-president of H. M. Byllesby & Co., was the speaker at a recent meeting of Byllesby Post of the American Legion at the Hotel Morrison, Chicago.

JOHN SLAVEN, connected with the Washington, D. C., office of the Chesapeake & Potomac Telephone Co. in various capacities since 1902, has been appointed assistant to president, with office at Baltimore.

J. M. LARKIN, assistant to the president of the Bethlehem Steel Co., Bethlehem, Pa., was elected chairman of the Industrial Relations Association of America at its recent annual meeting in Atlantic City, N. J.

H. P. CRAMER, who has been motor sales engineer with the General Electric Co., at Portland, Ore., for a number of years, has resigned to accept a position as manager of the Robert Skeen Electric Works, Portland.

A. T. HARDIN, vice-president of operation of the New York Central railroad, has been appointed by W. S. Murray, head of the super-power zone engineering staff, to the advisory board, representing the New York railroads.

C. D. YOUNG has been appointed by the American Society for Testing Materials as its representative on the Engineering Council to succeed Albert Ladd Colby. Mr. Young is general supervisor of stores for the Pennsylvania System, Broad Street Station, Philadelphia, and vice-president of the American Society for Testing Materials.

J. C. LAMB, for the past several years connected with the commercial department of the Tampa (Fla.) Electric Co., has been promoted to the position of commercial agent of the Baton Rouge (La.) Electric Co., vice W. R. Bell, who was transferred to a similar position with the Haverhill (Mass.) Gas Light Co. The three companies are under the management of Stone & Webster, Inc., Boston.

D. H. MCDOUGALL, of the Toronto Power Co., Toronto, Can., has been appointed chairman of the Canadian public relations section of the National Electric Light Association.

H. F. JACKSON, formerly vice-president and general manager of the Pacific Gas & Electric Co., San Francisco, is now general manager of the Great Western Power Co., San Francisco.

A. D. CHURCH, for the past few years district manager for the Midland Counties Light & Power Co., with headquarters at San Luis, Cal., has been transferred to the Santa Maria district of the company.

J. D. ROETT, sales engineer for the Union Switch & Signal Co., Swissvale, Pa., with headquarters in Chicago, has resigned in order to enter the service of the Standard Tank Car Co., Sharon, Pa., in the same capacity and with the same headquarters.

STACY HAMILTON has been appointed organization inspector of the Portland (Ore.) Railway, Light & Power Co. His new duties will include the making of special inspections, investigations and reports pertaining to the various departments and operating details of the company.

COL. EDWARD B. ELLICOTT has become associated as chief engineer with A. M. Castle & Co., iron and steel merchants, Chicago. In his new affiliation he will have charge of the company's new plant at Seattle, as well as the additional buildings to be erected by the company in Chicago. He will also be engaged in the operating and manufacturing activities of A. M. Castle & Co. and its associated interests. Colonel Ellicott was recently honorably discharged from the chemical warfare service of the United States after two and a half years of service, during which he constructed the No. 3 general hospital at Colonia, N. J., one of the four largest and most complicated war projects of the Government. Upon the completion of this project Colonel Ellicott was assigned as associate officer of the Building Division at Washington, and in January of this year he was assigned as department utilities officer on the staff of Maj. Gen. Leonard Wood, in command of the Central Department, at Chicago. Previous to entering the government service Colonel Ellicott was Chicago city electrician for eight years, and chief electrical engineer of the Chicago Sanitary District for 11 years, developing the hydroelectric power plant for the district. At the request of the officials of the Louisiana Purchase Exposition, St. Louis, he was granted a leave of absence and became chief mechanical and electrical engineer of the exposition. Colonel Ellicott is a member of the American Society of Mechanical Engineers, Western Society of Engineers, American Association of Engineers and a fellow of the American Institute of Electrical Engineers.

H. W. BUTLER has been designated as industries division engineer of the super-power zone engineering staff. Mr. Butler is a graduate of Cornell University and was connected with the Interborough Rapid Transit Co. until 1907, when he resigned to accept a position with J. G. White & Co., with whom he was engaged until 1913. Later he did consulting work in New York. During the war he was assigned to the aircraft production department of the army.

ALFRED M. STAEHLE, who has for the past three years been editor of *Blast Furnace & Steel Plant*, Pittsburgh, has resigned to become associated with the publicity department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Mr. Staehle will be engaged in the preparation of articles and literature for the industrial department. He is a graduate of the mechanical engineering course of the Carnegie Institute of Technology.

FREDERICK A. ANDERSON, now senior electrical engineer of the United States Shipping Board, Southern Pacific district, has been connected with the electrical industry since 1889 when he started work with the Sprague Electric Railway Co. From 1901 to 1916 he was in the engineering department of the United States Army, leaving that work to take up commercial electric welding, but at the outbreak of the world war he again joined the government forces.

KARL H. BRONSON has become associated with the Square D Co., Detroit, in the capacity of director of research engineering. Mr. Bronson is a graduate of the University of Michigan and has formerly been associated with the automotive industry. He was affiliated with Dodge Brothers, Detroit, in sales promotion and advertising work and later engaged in similar work for the Packard Motor Car Co., Detroit, from which company he resigned to join the Square D Co. Mr. Bronson will be actively engaged in the extensive safety campaigns which the Square D Co. is undertaking.

OBITUARY.

E. H. MULLIGAN, district manager of the Southern California Edison Co. at Redlands, Cal., died recently after a long illness.

SEWELL M. HOBSON, president of the Conway Electric Light Co., Conway, N. H., was killed instantly Aug. 2 when he came in contact with a live wire during an inspection of the plant.

GEORGE A. WOOLLEY, district manager of the General Electric Co. at Denver, Col., for the past five years, and an employe of the company for 30 years, died at his Denver home recently.

GEORGE FRANKLIN MARCHANT, aged 49 years, president of the George F. Marchant Co., 1420 South Rockwell street, Chicago, manufacturer of boilers and tools, died Aug. 4 at his home in Oak Park, Ill., from apoplexy.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Tauton, Mass.—The city council has awarded a contract to the Westinghouse Electric & Manufacturing Co., Pittsburgh, for extensions and improvements in the municipal electric-lighting system, to cost about $400,000. George F. Seibel is manager.

New Britain, Conn.—Bonds in the sum of $71,000 has been voted to construct electric conduits. Address O. F. Custer, mayor.

Waterbury, Conn.—The Connecticut Light & Power Co. has inaugurated construction on a two-story and basement addition to its plant on Freight street, 26 by 85 ft., to cost about $30,000.

Pawtucket, R. I.—The What Cheer Chemical Co. has awarded a contract to Joseph F. Cole, Niagara street, Providence, for the erection of a three-story power house at its plant, 40 by 60 ft., to cost about $45,000.

Providence, R. I. — Narragansett Electric Lighting Co. will double its turbine capacity, extending the present plant to make room for a 45,000-kw. turbine purchased from the Westinghouse Electric & Manufacturing Co. The cost of the improvement is estimated at $1,250,000.

Woonsocket, R. I.—Electrical and mechanical equipment will be installed in the proposed addition to the plant of the American Wringer Co., Pond street, estimated to cost about $100,000. This extension will be in conjunction with the erection of a similar extension, now under way, to cost approximately a like amount. Cooley & Marvin, Boston, are engineers.

Brooklyn, N. Y. — The Brooklyn Edison Co., 13 Willoughby avenue, has construction under way on a one-story power plant at 57 Washington avenue, to cost about $50,000.

Brooklyn, N. Y. — The New York Telephone Co., 15 Dey street, New York City, has filed plans for additions to its three-story exchange plant at 1052 Greene avenue, to cost about $30,000. Improvements and extensions will also be made in the company's plant at Throop avenue and McDonough street.

Gloversville, N. Y. — The Fulton County Gas & Electric Co. has been merged with the Mohawk Hydro-electric Co. under the first noted name. The company will operate with a capital of $1,732,000.

Hornell, N. Y.—The Hornell Electric Co. is planning the construction of an electric power plant at Hornellsville, with local distributing system for light and power service. Application for permission has been made to the Public Service Commission.

Louisville, N. Y. — The Louisville Power Corp. has made application to the Public Service Commission for permission to construction and operate a local electric light and power plant, and for approval of a franchise covering a number of local municipalities. The company plans to operate in St. Lawrence, Jefferson, Lewis, Oswego, Onondaga and Madison counties. Walter F. Wilson heads the company.

New York, N. Y. — Considerable electrical and mechanical equipment will be installed in the four-story addition to be erected at the plant of the Anheuser-Busch Ice & Cold Storage Co., 979 Brook avenue. The work is estimated to cost about $50,000.

New York, N. Y.—The New York Edison Co. will furnish service at the new building of the Fisk Rubber Co., Broadway and 57th street, now in course of construction. The installation will comprise about 6000 lamps, and about 500 hp. in mechanical equipment for operation of elevators, pumps, etc.

New York, N. Y.—The New York Edison Co., 130 East 15th streeet, has filed plans for the erection of its proposed new transformer stations on Cedar street and Elizabeth street, respectively. The first noted will be two-story brick structure, 25 by 74 ft., and is estimated to cost $150,000. The other building will be one story, 25 by 139 ft., and will cost a similar amount.

Olean, N. Y.—Plans have been completed for the installation of a new boiler plant to cost about $20,000 at the local high school.

Rossie, N. Y.—The Rossie Electric & Manufacturing Corp., recently incorporated with a capital of $50,000, is planning the operation of an electric light and power plant to serve this section. T. A. E. Young, J. W. and G. N. Wilson head the company.

Whitehall, N. Y. — Consolidated Light & Power Co. is planning the erection of a new power plant the details of which will be announced later.

Camden, N. J.—The Victor Talking Machine Co. has arranged for the immediate erection of the proposed power plant at its works, to be used for increased power production for factory service.

Camden, N. J.—Electrical and mechanical equipment will be installed in the proposed ice manufacturing plant to be erected by the Camden Ice Co. at Third and Cedar streets, Woodlynne. The plant will include an engine and boiler department, each 40 by 40 ft. The entire factory is estimated to cost about $150,000.

Elizabeth, N. J.—The board of education is planning the erection of a new power house in connection with an addition to the local high school on South street. Plans will be ready, it is understood, in September. The entire work is estimated to cost about $350,000.

Pleasantville, N. J.—The city council has appointed a committee to investigate costs and construction details regarding the installation of a municipal gas plant and waterworks. The latter project will include an electrically operated pumping plant.

Three Bridges, N. J.—The Raritan Valley Hydraulic Electric Co., recently incorporated, is planning the construction of an electric power plant in this section. C. W. Alpaugh, Bernardsville, heads the company.

Trenton, N. J.—The Jackson Electric Motor Repairing Co., 38 Bellevue avenue, is having plans prepared for the erection of a one-story works, 42 by 100 ft., on Belvidere street, to cost about $12,000.

Harrisburg, Pa. — The Harrisburg Light & Power Co. has called a special meeting of stockholders on Sept. 24, to approve an increase in capital from $3,300,000 to $5,050,000. The proceeds will be used in part for proposed extensions and improvements in electric plant and system. H. W. Stone is secretary.

Harrisburg, Pa.—The Public Service Commission is considering the application of a number of electric companies for increased rates for light and power service, including the St. Mary's Electric Light Co., Gettsyburg Gas Co., the Union Light & Heat Co., Chester Valley Electric Co., Ridgway Electric Light Co., Kane Electric Light & Power Co., and the Johnsonburg Light & Power Co.

Philadelphia, Pa.—The Philadelphia & Reading Railroad has awarded contract to C. C. Pacek, Cynwid, Pa., for the erection of an electric substation on Arch street, one-story 60 by 68 ft., to cost about $15,000.

Philadelphia, Pa.—Ferguson Carpet Co. will erect a one-story, 40x75 ft. power plant at its works at Stenton and Rockland streets. Bids will be accepted now.

Philadelphia, Pa. — The Electric Storage Battery Co. has filed plans for the erection of a new three-story brick and concrete plant on Rising Sun lane, to cost about $192,000. A one-story mechanical building will also be constructed at a cost of $20,000.

York, Pa.—Considerable electrical and mechanical equipment will be installed by the York Mfg. Co. in the addition to its plant. The company specilizes in the manufacture of ice-making and refrigerating machinery, and has acquired the former plant of the Katz Brewing Co. The different buildings will be remodeled and improved.

Grafton, W. Va.—The Parish Realty Co. is planning the installation of an electric lighting system on an 85-acre tract of property to be developed at Blueville, W. Va.

Baltimore, Md.—The Consolidated Gas, Electric Light & Power Co. is having plans prepared for the erection of two electric plants, 52 by 200 ft., and 29 by 108 ft., on Race and Barney

streets, respectively. The company is also considering plans for the construction of a new steam-operated generating plant at Dundalk.

Anderson, S. C. — The Flat Rock Light & Power Co. has been organized with a capital of $5000, to operate a local electric light and power system. The incorporators are W. L. Hays, J. Wesley Brown and L. C. Keys.

Charleston, S. C.—The Oceanic Power Co. is being organized by William Gregersen, W. P. Tillinghast and others.

Townville, S. C. — The Townville Water, Light & Power Co., has been organized to install an electric plant. Address Dr. Webb, president, or E. B. Farmer, secretary.

Butler, Ga.—A stock company is being formed for the purpose of developing water power on White Water creek, south of Butler, with the intention of supplying electric energy to neighboring places. Information may be obtained from C. E. Benns.

Columbus, Ga.—Plans for the instal'ation of a "white way" lighting system to cost $21,000 are being prepared, the new installation to be in operation within 60 days.

Payne City, Ga.—The city council has perfected plans for improvements and extensions in the electric lighting system. L. W. Greene is mayor.

Taylorsville, Ga.—The Taylorsville Light & Power Co. has been organized with a capital of $8000, to operate a local electric light and power system. The incorporators are Will M. Dorsey, C. D. Shaw and A. R. McGinnis.

Valdosta, Ga. — In addition to a bond issue of $10,000 already voted for a municipal electric light plant, the Chamber of Commerce has petitioned the city to call another bond election for the purpose of voting a sufficient amount of bonds to build and equip a plant that will care for the city's needs now and for many years to come.

Woodbury, Ga.—For the purpose of improving the water and electric light systems the city has voted bonds for $35,000. Address S. P. Wilburn, clerk.

New Smyrna, Fla.—The city has purchased and will enlarge the electric lighting system of the New Smyrna Public Service Co. Address the mayor.

Perry, Fla. — The Perry & Gulf Traction Co. has voted an increase of capital stock from $100,000 to $1,000,000. The road will be extended to Cedar Key from Perry, work to start at the earliest possible date.

NORTH CENTRAL STATES.

Rudolph, O.—The Rudolph Light & Power Co. has been incorporated with a capital stock of $10,000 by W. J. Shuler and others to build and operate an electric plant.

Martins Ferry, O.—The question of issuing $450,000 of municipal lighting bonds will be submitted to vote at the November election.

Carson City, Mich.—The Fargo Engineering Co., of Jackson, has prepared plans for a $150,000 municipal power plant.

Traverse City, Mich.—The city is having plans prepared for a municipal steam-electric power plant to cost $75,000.

Anderson, Ind.—The city has had plans prepared for a municipal electric plant to cost $300,000. J. Essington is city clerk.

Brockton, Ill.—Plans are in course of preparation for the development of a new street-lighting system here.

Newton, Ill. — Citizens have voted $25,000 for the improvement of the light and water plant.

Princeton, Ill.—An appropriation of $17,000 has been made for the purchase of an additional unit to be installed in the municipal electric light plant, to develop 400 hp.

Springfield, Ill.—The city council has authorized the purchase and installation in the municipal electric plant of a condenser to cost about $10,000.

Springfield, Ill.—A demand that the city provide better lighting service on Fourth street, has been made upon Commissioner Willis J. Spaulding by a delegation from the Chamber of Commerce and Springfield Automobile Club. Address Robert W. Troxell.

Milwaukee, Wis.—The Columbia Rubber Co., 176 Sixteenth street, is planning to erect a factory and powerhouse at an approximate cost of $75,000.

Peshtigo, Wis.—The Peshtigo Pulp & Paper Co. has awarded a contract to the Jorgenson Construction Co., Denmark, for the construction of a hydroelectric power plant and dam about five miles from Peshtigo. L. A. DeGuere, Grand Rapids, is the engineer.

Sheboygan, Wis.—Plans have been prepared by Foeller & Schobber, architects, for a $35,000 power house for the St. Nichols hospital. P. Reiss, director.

Fairmont, Minn.—Plans are being prepared for the Martin County Electric Service Co., Inc., for 28 miles of transmission lines from Fairmont, through Welcome and Ceylon, to Dunnell, to connect with the Fairmont plant. W. E. Skinner, 3241 Aldrich avenue South, Minneapolis, is the construction engineer.

Independence, Minn.—The village has voted to extend the electric transmission lines of the Wisconsin-Minnesota Light & Power Co., Winona, to this place, the work to be started at once.

Milaca, Minn.—The city contemplates changing the lighting and power service from direct current to alternating current, with the installation of a new generator.

Grant, Ia.—Plans are being considered for a special election to vote bonds for an electric light plant.

Manchester, Ia.—Survey has been made by Engineer W. E. Skinner for a municipal power plant and water mains. Address T. Wilson, city clerk.

Vinton, Ia.—For the purpose of improving the electric light and water system $45,000 has been voted.

Butler, Mo.—A special election has been held here which carried by a large vote the proposition of bonds in the amount of $65,000 for an electric light plant.

St. Louis, Mo.—The Swift Co., Chicago, has plans for the construction of an addition to its St. Louis power plant, to cost $100,000.

St. Louis, Mo.—The David Rankin Junior school has awarded to Joseph Stewart & Son, Boatman's building, the contract for an addition to its power house at a cost of about $15,000. Eames & Young, Arcade building, are the architects.

Wentzville, Mo.—City officials contemplate the erection of an electric lighting and power plant to cost approximately $30,000. E. T. Archer & Co., 609 New England building, Kansas City, is the architect.

Sioux Falls, S. D.—Improvements are under contemplation for the electric lighting system, to cost approximately $175,000.

SOUTH CENTRAL STATES.

Louisville, Ky. — The Louisville Gas & Electric Co. is planning extensive improvements and additions in its electric plants and system. Donald McDonald is general manager.

Englewood, Tenn. — The Eureka Cotton Mills is planning the installation of equipment for the electrical operation of the entire plant. J. L. Ferguson is treasurer and manager.

Memphis, Tenn.—Iten Biscuit Co., of Omaha, Nebr., will install a large electric power plant at its new Memphis factory for factory service, the entire plant to cost approximately $500,000.

Birmingham, Ala.—The Alabama Power Co., with main office at Birmingham, will install the sixth unit at the company's Lock No. 12 plant on the Coosa river to provide 19,000 hp., increasing the total power production at this plant to 105,000 hp. The new unit will be completed within one year.

Florence, Ala.—The city will erect electric light posts for a "white way" around the city park. Address the mayor.

Huntsville, Ala.—Plans are being made for the electrification of the plant of the Margaret Mills here. T. B. Reynolds is superintendent.

Cleveland, Miss.—The Home Light & Ice Co. has filed notice of an increase in capital stock from $10,000 to $40,000 for the purpose of making extensions to its electric light plant.

Shaw, Miss.—The town light and water department will install engines of 150 and 100 hp. Address the mayor.

Little Rock, Ark.—Government approval is sought by the Dixie Power Co. for the construction of a dam in the White river, 200 ft. high, for power purposes. Walter Powell is president and Henry A. Allen, Chicago, is the engineer.

Pine Bluff, Ark. — The Arkansas Light & Power Co. has perfected plans for the construction of a new 6600-volt high-tension line from Pine Bluff to Cottondale, to cost about $15,000.

Violet, La.—The Violet Ice & Electric Co. has been organized with a capital of $50,000 to operate a local electric power plant and ice-manufacturing works. The incorporators are Eri Vaughn and Uri Vaughn.

Amarillo, Tex.—The Amarillo Gas & Electric Co. suffered the loss of approximately $100,000 from a fire which swept the electric plant. Im-

mediate repairs will be made and new electric generating equipment will be installed.

Beaumont, Tex.—An electric crane will be installed in the reinforced concrete foundry, pattern shop and storage plant which will be erected by the Beaumont Iron Works.

Memphis, Tex.—The light and ice plant, which was destroyed by fire July 25, will be rebuilt.

WESTERN STATES.

Phoenix, Ariz.—The Paradise-Verde Irrigation District of Phoenix is preparing plans for the construction of a power plant on the Verde river, to cost from $16,000,000 to $20,000,000.

Albuquerque, N. M.—The Albuquerque Gas & Electric Co. will install boilers and make other improvements at its power plant. Arthur Prager is manager.

Seattle, Wash.—That the city of Seattle already has expended $833,930 on construction work on the so-called Skagit river project to furnish cheap electric power to the city is shown in a report just issued by the city controller. A bond issue of $5,500,000 has been authorized by the City Council to finance the project. Of this, $1,500,000 worth have been sold, leaving $4,000,000 for sale. The net proceeds of the bonds sold, after the discount was deducted, amounted to $1,383,900. Of this sum, $950,650 has already been appropriated by the City Council, although not all of these appropriations have been expended.

Bend, Ore.—The Bend Water, Light & Power Co. is planning the development of the Tumalo creek power site by the erection of an electric power plant at an approximate cost of $225,000, work to start soon. Charles A. Brown is president.

Seattle, Wash.—The Puget Sound Power & Light Co. is seeking a 50-year franchise for the purpose of extending transmission lines into territory covering 30 roads in Whatcom county.

Portland, Ore.—Architect E. Kroner, Worcester building, is preparing plans for a power plant at the Emanuel hospital, Stanton and Commercial streets, to cost approximately $75,000.

Long Beach, Cal.—Plans are being made for the installation of a lighting system on Ocean boulevard to include the placing of standards on both sides of the boulevard between Alamitos and Termino avenues.

CANADA.

Liverpool, N. S.—The city is having plans prepared for the erection of a power plant, at a cost of $30,000. Smart & Burnett, 10 Cathcart street, Montreal, Que., are the engineers on the project.

St. Johns, N. B.—Arrangements are being made to electrify the plant of the New York Cotton Mills.

St. Margarets Bay, N. S.—The S. Morgan Smith Co., York, Pa., has obtained the contract for furnishing the turbine engines in connection with the $1,000,000 power plant development at St. Margarets Bay.

Chatham, Ont.—The city is having plans prepared for alterations in the city waterworks pumping station, including the installation of electrically-driven centrifugal pumps, etc. The estimated cost is $50,000. E. A. James Co., Ltd., 36 Toronto street, Toronto, Ont., is the engineer on the project.

Hamilton, Ont.—The city has voted $15,000 in bonds for the purpose of constructing an electric light plant.

London, Ont.—The utility commissioners are having plans prepared for a new power dam at Springback, to cost about $200,000.

Port Arthur, Ont.—The Kaministiquia Pulp & Paper Co. plans to install a hydroelectric plant in its new pulp mill. The cost is estimated at $1,000,000. C. D. Howe is the engineer in charge of the project.

St. Catharines, Ont.—The Grand Trunk Railway is considering the electrification of its system from Port Colborne to Port Dalhousie.

St. Catharines, Ont.—Fire, July 18, destroyed the power plant and transformer station of the Niagara, St. Catharines & Toronto Railway Co. The structure will be rebuilt at once.

Windsor, Ont.—Contracts have been awarded in connection with the building of a factory and power house for the branch factory of the Burroughs Adding Machine Co., Detroit. The estimated cost of the plant is about $250,000.

Brandon, Man.—G. L. Guy, a member of the Manitoba Utilities Commission, and William Scott, a consulting engineer, have been engaged by the city to make a survey of the waterworks system with a view of electrifying the system. The estimated cost of the improvements is $35,000.

Alice Arm, B. C.—The Dolly Varden Mining Co. has awarded a contract for a hydroelectric plant, to cost $65,000. W. V. Hunt, 1652 Eighth avenue, Vancouver, B. C., is the engineer in charge of the project.

PROPOSALS.

Minnewaukan, N. D.—The county of Benson will receive bids on Sept. 8 for the installation of an electric lighting plant. Address G. A. Gilbertson, county auditor.

Bellevue, Pa.—Bids will be received Aug. 30 for two 25-hp., 1200-r.p.m., three-phase, 60-cycle, 220-volt, slip-ring motors with controllers, bed plates and pulleys. Address James W. Graham, 545 Teece avenue.

Des Moines, Ia.—The State Board of Commissioners, Capitol building, will soon receive bids for the construction of a power plant to cost approximately $200,000. The Canfield Engineering Co., Flynn building, is the engineer.

Ogden, Utah.—Sealed proposals will be received Sept. 4 by the office of the Construction Quartermaster, 317 Colonel, Hudson buidling, Ogden, for the construction of 60 buildings, water system, electrical layout and other utilities at a location near Ogden.

Owosso, Mich.—The city commission will receive bids until 1 p. m., Sept. 1, for the construction of a system of boulevard lights consisting of 178 Monolight standards, approximately 23,000 ft. of 5000-volt armored cable, transformers, cable, etc. Plans and specifications are on file at the office of city clerk. Copies may be obtained on deposit of $5, which will be refunded upon return of the plans and specifications in good order before Sept. 1. A certified check for $500 is required with each bid. Address B. K. Lucas, city clerk.

FOREIGN TRADE.

Electrical Equipment, (33,232)—A company in Venezuela desires to purchase all machinery and equipment, excepting poles, for the installation of an electric light plant to maintain from 800 to 900 incandescent lamps of 25 cp. each, to be installed in two towns of that country. Wire of sufficient size should be quoted by the 1000 ft. or by weight. Correspondence in Spanish is solicited. Quotations should be given f. o. b. New York, or c. i. f. Maracaibo.

Electric Supplies (33,293)—A commission firm in Rumania desires to be placed in communication with manufacturers for the sale in that country of hosiery, underwear, knit goods, gloves, shirts, boots and shoes, piece goods, automobiles, tires, tubes, and accessories, musical instruments, electrical supplies, agricultural machinery, and hand tools of every description. Correspondence may be in English.

INCORPORATIONS

Toledo, O.—Frankfort Electric Co. Capital, $50,000. Incorporators: A. Jordan, J. E. Jordan and others.

Beebe, Ark.—The Beebe Light & Power Co. Capital, $20,000. Incorporators: C. A. Miller and others.

Dover, Del.—The Res-Pro Insulating Co., Inc. Capital $3,000,000. To manufacture electrical machinery, parts, etc. Incorporators: Frank Jackson, W. I. N. Lofland and Mark W. Cole.

Yonkers, N. Y.—Electro-Shine Co. Capital stock, $350,000. To manufacture electrical machinery for buffing shoes, parts, etc. Incorporators: T. M. Hill, F. Kingsley and J. B. Bubereuil, Yonkers, N. Y.

New York, N. Y.—The Halliwell Electric Corporation. Capital, $100,000. To manufacture electrical equipment and parts. Incorporators: R. H. and E. A. Brown, and J. Jorgenson, 661 West 139th Street, New York.

New York, N. Y.—The American Power Appliance Corp. Capital, $500,000. To manufacture engines and machine parts. Incorporators: G. A. Senior, J. F. Brandenburg and F. C. Briggs, 68 Montague Street, Brooklyn.

Stamford, Conn.—The Petroleum Heat & Power Co. of Connecticut. Capital stock, $500,000. To manufacture oil-burning equipment, parts, etc. Incorporators: R. E. Hackett, National Bank building; Colin Ingersoll and J. W. Madigan, Stamford.

Newark, N. J.—The Libby Welding Co., 113 Frelinghuysen avenue, has been incorporated with capital stock of $50,000, to manufacture welding equipment and other mechanical apparatus. Clifford S. Libby, Louis K. Schwartz and Frank P. Russell are the incorporators.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

A. T. & T. Earnings Continue to Increase.

Directors of American Telephone & Telegraph Co. meet in Boston this week for dividend purposes and the regular quarterly distribution of $2 a share is expected. Earnings continue to be best in the company's history. The six months ended June 30 showed a surplus of $26,328,663 after taxes and charges, equivalent to $5.95 a share on $441,981,200 capital stock. This compares with $13,052,446, equal to $2.95 a share for the first quarter, so that the company did slightly better in the second quarter of the year. At this rate the company will earn at least $12 a share on its stock for 1920, which will leave a 50% margin over dividend requirements.

The stock, selling around 96, is less than 5 points below the best of the year, and investment buying has been increasing of late. Many of the leading investment houses say there is a country-wide demand for the stock, particularly from smaller investment sources, which accounts for the rapidly increasing size of the stockholders' list.

There is no talk of new financing at this time. The company has $50,000,000 notes due in 1922 and another $40,000,000 in 1924.

Electric Storage Battery Co. Reports Large Gross Sales.

Consolidated income acocunt of the Electric Storage Battery Co. for five months ended May 31, 1920, as filed with the New York Stock Exchange, shows gross sales of $2,918,495; net earnings from sales, $2,094,081; other income, $205,151; net income for period before taxes, $2,299,232; dividends on preferred and common stock, $416,230; surplus for period, $1,883,002.

The condensed balance sheet as of May 31, 1920, is as follows: Assets—Property account, $16,172,804; investments, $7,623,130; cash, $661,405; accounts receivable, $3,863,039; inventories, $6,282.592; deferred items, $592,670; total, $35,195,640. Liabilities—Preferred stock, $87,500; common stock, $16,661,925; accounts payable and sundries, $870,160; reserves, $2.334,630; profit and loss surplus, $15,241,425; total, $35,195,640.

Habirshaw Electric Cable Co. Exchanges Bonds.

Notice has been given by the Habirshaw Electric Cable Co. that its temporary sinking fund gold debenture bonds, Series A, may be exchanged without charge for a like principal amount of definitive engraved sinking fund gold debenture bonds, Series A, authenticated by the trustee and with all matured interest coupons attached, at the office of the trustee, Guaranty Trust Co., 140 Broadway, New York City, on and after Aug. 25.

Galveston-Houston Electric Co.

	1920.	1919.
May gross	$ 334,843	$ 248,596
Net earnings	104,949	66,983
Surplus after charges	69,644	31,345
Twelve months' gross	3,315,950	2,898,993
Net earnings	844,761	815,627
Surplus after charges	462,421	443,203

Manila Electric Railroad & Lighting Corp.

	1920.	1919.
May gross	$ 280,088	$ 202,371
Net after taxes	92,713	72,306
Total income	92,770	72,384
Surplus after charges	60,841	42,930
Twelve months gross.	2,885,365	2,522,687
Net after taxes	839,025	1,143,179
Total income	841,618	1,134,860
Surplus after charges	474,628	826,567
Balance after preferred dividends	174,628	526,567

American Light & Traction Head Discusses Dividends.

The American Light & Traction Co. for the twelve months ended June 30, 1920, reports earnings as follows:

	1920.	1919.
Gross earnings from subsidiary companies	$4,162,515	$4,211,398
Net earnings	3,894,234	3,971,717

During the twelve months ended June 30, 1920, cash dividends on the preferred stock required $854,172, and the common stock $2,340,491. Stock dividends on the common stock required $2,340,491, making a total deduction for all dividends for the twelve months of $5,535,154.

Commenting on the action of the directors in cutting the common dividend from 2½% in cash and stock to 1¾% quarterly, Alanson P. Lathrop, president, says: "The reduction in the common stock dividend, as compared with previous quarter, was deemed advisable in consequence of the decreased earnings due to the abnormal advances in cost of material and labor, and to the necessity, of conserving cash to take care of extensions and betterments required by the subsidiary companies to meet franchise requirements."

New England Co. Power System.

	1920.	1919.
June gross	$ 486,254	$ 297,765
Net after taxes	136,861	109,332
Surplus after charges	69,121	44,302
Twelve months' gross	5,162,192	3,839,984
Net after taxes	1,545,312	1,386,625
Surplus after charges	775,253	642,572

Lowell Electric Light Corp.

	1920.	1919.
June gross earnings	$ 94,137	$ 72,367
Net earnings	17,081	21,248
Surplus after charges	14,891	19,081
Twelve months' gross	1,118,207	988,734
Net earnings	327,982	247,135
Surplus after charges	304,574	224,636

American Power & Light Co.

(Earnings of subsidiaries of the American Power & Light Co.)

	1920.	1919.
May gross	$1,654,557	$1,228,184
Net earnings	585,239	435,127
Twelve months' gross.	18,204,413	14,783,915
Net earnings	6,946,863	5,514,004

Eastern Texas Electric Co.

	1920.	1919.
June gross earnings	$ 134,052	$ 110,620
Net earnings	44,566	39,958
Surplus after charges	34,453	32,847
Twelve months' gross	1,498,941	1,244,435
Net earnings	578,958	477,487
Surplus after charges	419,075	329,590

Columbus Electric Co.

	1920.	1919.
June gross earnings	$ 130,288	$ 104,852
Net earnings	55,747	45,387
Surplus after charges	24,601	15,075
Twelve months' gross	1,482,470	1,199,899
Net earnings	643,553	550,244
Surplus after charges	273,773	194,169

Blackstone Valley Gas & Electric Co.

	1920.	1919.
June gross earnings	$ 271,326	$ 201,721
Net earnings	67,885	40,894
Surplus after charges	42,952	15,774
Twelve months' gross	3,018,777	2,527,722
Net earnings	923,873	636,135
Surplus after charges	625,315	345,212

Dividends.

The Electric Investment Corp. has declared its regular quarterly dividend of 1¾% on its preferred stock, payable Aug. 21 to stockholders of record Aug. 11.

Federal Utilities, Inc., has declared its regular quarterly dividend of 1½% on its preferred stock, payable Sept. 1 to stockholders of record Aug. 14.

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate Per cent.	Bid Aug. 10.	Bid Aug. 17
Adirondack Electric Power of Glens Falls, common	6	14	14
Adirondack Electric Power of Glens Falls, preferred	6	70	70
American Gas & Electric of New York, common	10+extra	96	95
American Gas & Electric of New York, preferred	6	33	33
American Light & Traction of New York, common	..	111	110
American Light & Traction of New York, preferred	6	80	81
American Power & Light of New York, common	4	40	44
American Power & Light of New York, preferred	6	60	65
American Public Utilities of Grand Rapids, common	..	3	..
American Public Utilities of Grand Rapids, preferred	7	10	..
American Telephone & Telegraph of New York	..	96⅛	96⅛
American Water Works & Elec. of New York, common	..	2	1
American Water Works & Elec. of New York, particip.	7	3	3
American Water Works & Elec. of New York, 1st preferred	..	34	36
Appalachian Power, common	..	1	1
Appalachian Power, preferred	7	15	15
Cities Service of New York, common	+extra	265	274
Cities Service of New York, preferred	6	64	65
Commonwealth Edison of Chicago	8	101	101
Comm. Power, Railway & Light of Jackson, common	..	16	17
Comm Power, Railway & Light of Jackson, preferred	6	38	34
Federal Light & Traction of New York, common	..	6	7
Federal Light & Traction of New York, preferred	..	40	40
Northern States Power of Chicago, common	..	27	29
Northern States Power of Chicago, preferred	ex.div.7	74	74
Pacific Gas & Electric of San Francisco, common	..	45¼	46
Public Service of Northern Illinois, Chicago, common	7	67	65
Public Service of Northern Illinois, Chicago, preferred	6	83	83
Standard Gas & Electric of Chicago, common	..	11	12
Standard Gas & Electric of Chicago, preferred	6	35	35
Tennessee Railway, Light & Power of Chattanooga, com.	..	½	½
Tennessee Railway, Light & Power of Chattanooga, pfd.	6	2	2
United Light & Railways of Grand Rapids, common	4	18	17
United Light & Railways of Grand Rapids, preferred	6	55	56
Western Power of San Francisco, common	..	19	16
Western Union Telegraph of New York	extra.	82⅝	..
Industrials—			
Electric Storage Battery of Philadelphia, common	4	95	94
General Electric of Schenectady	8	136¾	139⅛
Westinghouse Electric & Mfg. of Pittsburgh, common	7	45½	47